PUBLIC HEALTH RESEARCH

VOLUME 7 ISSUE 2 JANUARY 2019
ISSN 2050-4381

Health impacts of environmental and social interventions designed to increase deprived communities' access to urban woodlands: a mixed-methods study

Catharine Ward Thompson, Eva Silveirinha de Oliveira, Sara Tilley, Aldo Elizalde, Willings Botha, Andrew Briggs, Steven Cummins, Alastair H Leyland, Jenny J Roe, Peter Aspinall, Katherine Brookfield and Richard Mitchell

NHS
National Institute for Health Research

DOI 10.3310/phr07020

Health impacts of environmental and social interventions designed to increase deprived communities' access to urban woodlands: a mixed-methods study

Catharine Ward Thompson,[1]*
Eva Silveirinha de Oliveira,[1] Sara Tilley,[1]
Aldo Elizalde,[2,3] Willings Botha,[4,5] Andrew Briggs,[4]
Steven Cummins,[6] Alastair H Leyland,[2]
Jenny J Roe,[7,8,9] Peter Aspinall,[7] Katherine Brookfield[1]
and Richard Mitchell[2]

[1]OPENspace Research Centre, Edinburgh College of Art, University of Edinburgh, Edinburgh, UK
[2]Medical Research Council/Chief Scientist Office Social and Public Health Sciences Unit, University of Glasgow, Glasgow, UK
[3]Adam Smith Business School, University of Glasgow, Glasgow, UK
[4]Health Economics and Health Technology Assessment, Institute of Health and Wellbeing, University of Glasgow, Glasgow, UK
[5]National Perinatal Epidemiology and Statistics Unit, Centre for Big Data Research in Health, School of Women's and Children's Health, University of New South Wales, Sydney, NSW, Australia
[6]Department of Social and Environmental Health Research, London School of Hygiene & Tropical Medicine, London, UK
[7]School of Energy, Geoscience, Infrastructure and Society, Heriot-Watt University, Edinburgh, UK
[8]Stockholm Environment Institute, University of York, York, UK
[9]Center for Design and Health, University of Virginia, Charlottesville, VA, USA

*Corresponding author

Declared competing interests of authors: Steven Cummins and Alastair H Leyland were members of the National Institute for Health Research (NIHR) Public Health Research Funding Board at the time of application for grant funding; however, they played no role in the discussions or decision on the funding of this project. Steven Cummins is supported by a UK NIHR Senior Research Fellowship. Richard Mitchell, Alastair H Leyland and Aldo Elizalde declare that the Social and Public Health Sciences Unit, University of Glasgow, received core support from the Medical Research Council (reference numbers MC_UU_12017/10 and MC_UU_12017/13) and the Scottish Government Chief Scientist Office (reference numbers SPHSU10 and SPHSU13). Andrew Briggs reports grants from NIHR during the conduct of this study, outside the submitted work. Willings Botha received support from a Forestry Commission Scotland (FCS)-funded studentship during the course of the study, supervised by Andrew Briggs and Richard Mitchell. Catharine Ward Thompson and Richard Mitchell report grants from FCS prior to the commencement of this project and co-supervision of FCS-funded studentships that drew on the project described in the report. Catharine Ward Thompson was lead

researcher (2006–11) on commissioned research funded by FCS to undertake an evaluation of some of its Woods In and Around Towns programme. Richard Mitchell is a non-remunerated director of a charity (Paths For All), which delivers, and advocates for, walking for health.

Published January 2019
DOI: 10.3310/phr07020

This report should be referenced as follows:

Ward Thompson C, Silveirinha de Oliveira E, Tilley S, Elizalde A, Botha W, Briggs A, *et al*. Health impacts of environmental and social interventions designed to increase deprived communities' access to urban woodlands: a mixed-methods study. *Public Health Res* 2019;**7**(2).

Public Health Research

ISSN 2050-4381 (Print)

ISSN 2050-439X (Online)

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: journals.library@nihr.ac.uk

The full PHR archive is freely available to view online at www.journalslibrary.nihr.ac.uk/phr. Print-on-demand copies can be purchased from the report pages of the NIHR Journals Library website: www.journalslibrary.nihr.ac.uk

Criteria for inclusion in the *Public Health Research* journal

Reports are published in *Public Health Research* (PHR) if (1) they have resulted from work for the PHR programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

Reviews in *Public Health Research* are termed 'systematic' when the account of the search, appraisal and synthesis methods (to minimise biases and random errors) would, in theory, permit the replication of the review by others.

PHR programme

The Public Health Research (PHR) programme, part of the National Institute for Health Research (NIHR), evaluates public health interventions, providing new knowledge on the benefits, costs, acceptability and wider impacts of non-NHS interventions intended to improve the health of the public and reduce inequalities in health. The scope of the programme is multi-disciplinary and broad, covering a range of interventions that improve public health. The Public Health Research programme also complements the NIHR Health Technology Assessment programme which has a growing portfolio evaluating NHS public health interventions.

For more information about the PHR programme please visit the website: http://www.nets.nihr.ac.uk/programmes/phr

This report

The research reported in this issue of the journal was funded by the PHR programme as project number 10/3005/18. The contractual start date was in April 2012. The final report began editorial review in October 2017 and was accepted for publication in June 2018. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The PHR editors and production house have tried to ensure the accuracy of the authors' report and would like to thank the reviewers for their constructive comments on the final report document. However, they do not accept liability for damages or losses arising from material published in this report.

This report presents independent research funded by the National Institute for Health Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, NETSCC, the PHR programme or the Department of Health and Social Care. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, NETSCC, the PHR programme or the Department of Health and Social Care.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Prepress Projects Ltd, Perth, Scotland (www.prepress-projects.co.uk).

Abstract

Health impacts of environmental and social interventions designed to increase deprived communities' access to urban woodlands: a mixed-methods study

Catharine Ward Thompson,[1]* Eva Silveirinha de Oliveira,[1] Sara Tilley,[1] Aldo Elizalde,[2,3] Willings Botha,[4,5] Andrew Briggs,[4] Steven Cummins,[6] Alastair H Leyland,[2] Jenny J Roe,[7,8,9] Peter Aspinall,[7] Katherine Brookfield[1] and Richard Mitchell[2]

[1]OPENspace Research Centre, Edinburgh College of Art, University of Edinburgh, Edinburgh, UK
[2]Medical Research Council/Chief Scientist Office Social and Public Health Sciences Unit, University of Glasgow, Glasgow, UK
[3]Adam Smith Business School, University of Glasgow, Glasgow, UK
[4]Health Economics and Health Technology Assessment, Institute of Health and Wellbeing, University of Glasgow, Glasgow, UK
[5]National Perinatal Epidemiology and Statistics Unit, Centre for Big Data Research in Health, School of Women's and Children's Health, University of New South Wales, Sydney, NSW, Australia
[6]Department of Social and Environmental Health Research, London School of Hygiene & Tropical Medicine, London, UK
[7]School of Energy, Geoscience, Infrastructure and Society, Heriot-Watt University, Edinburgh, UK
[8]Stockholm Environment Institute, University of York, York, UK
[9]Center for Design and Health, University of Virginia, Charlottesville, VA, USA

*Corresponding author c.ward-thompson@ed.ac.uk

Background: Contact with natural environments can bring health benefits, but research is lacking on how changes in access to natural environments might improve health, especially for deprived populations.

Objective: To evaluate the health impacts of woodland environment interventions intended to increase communities' engagement with these woodlands.

Design: A prospective study of Forestry Commission Scotland's Woods In and Around Towns (WIAT) programme in deprived communities to enhance public access to natural environments. The study investigated the impact that WIAT had on community-level mental health over time.

Setting: Three intervention and three control woodland sites, and associated communities within 1.5 km of the woodlands, located in central Scotland and eligible for WIAT support.

Participants: A core community survey was administered at each site in three waves, at baseline and after each phase of intervention ($n = 5460$, panel A). The completed survey contained a nested longitudinal cohort ($n = 609$, panel B). Community members also undertook 6-monthly environmental audits at all sites ($n = 256$) and participated in post-intervention focus groups ($n = 34$).

Interventions: Phase 1 involved physical changes to the woodlands, including footpaths, entrances and vegetation. Phase 2 involved community engagement events promoting woodland use.

Main outcome measures: The primary outcome was the Perceived Stress Scale (PSS). Other health measures included health-related quality of life (HRQoL) EuroQol-5 Dimensions (EQ-5D), physical activity (PA) [International Physical Activity Questionnaire (IPAQ)], connectedness to nature [Inclusion of Nature in Self (INS) scale] and social cohesion.

Results: The PSS scores significantly increased in the intervention group and marginally decreased in the control group. Multilevel regression models showed a differential impact between the intervention and the control at survey wave 3 in panel A [*B* (unstandardised coefficient) 3.58, 95% confidence interval (CI) 2.85 to 4.31; $p < 0.001$] and in panel B [*B* 3.03, 95% CI 1.54 to 4.52; $p < 0.001$]. Using the same analytical approach, no significant change in HRQoL was associated with the intervention. Economic assessment included an illustrative cost–utility analysis and a cost–consequences analysis. The differential in stress between the intervention group and the control group was lower or non-significant in those who visited 'nature' in the previous year [panel A, *B* 1.9, 95% CI 0.8 to 3.0; $p < 0.001$; panel B, *B* 0.64, 95% CI –1.60 to 2.88; $p = 0.57$]. The IPAQ score showed a positive association with the intervention for moderate levels of PA [panel B, *B* 559.3, 95% CI 211.3 to 907.2; $p = 0.002$] and overall PA [panel B, *B* 861.5, 95% CI 106.5 to 1616.4; $p = 0.025$]. The intervention was also associated with increased nature connectedness and social cohesion by wave 3 – significant for panel A only. Qualitative and quantitative evidence showed that interventions increased the perceived quality of the woodland environment and enhanced its enjoyment for different activities, but the increase in use of natural environments post intervention was only 6% (panel B).

Limitations: This study was limited to three intervention sites. External factors may be the primary influence on health outcomes.

Conclusions: The WIAT interventions did not improve community-level health within 6 months of completion, and hence there was no basis for demonstrating cost-effectiveness. However, the WIAT interventions are low cost (average £11.80 per person in the eligible population) and have potential for cost-effectiveness, if health benefits were found in the longer term.

Future work: Using routinely collected data to consider a whole-programme evaluation is recommended.

Funding: The National Institute for Health Research Public Health Research programme.

Contents

List of tables

List of figures

List of boxes

List of supplementary material

Report Supplementary Material 1 Core community survey questionnaire, 2013–15

Report Supplementary Material 2 Community survey introduction letter, 2013 – wave 1

Report Supplementary Material 3 Community survey introduction letter to named participant from wave 1, 2014 and 2015 – waves 2 and 3

Report Supplementary Material 4 Community survey introduction letter to new household, 2014 and 2015 – waves 2 and 3

Report Supplementary Material 5 Focus group and interview question schedule, 2015 and 2017

Report Supplementary Material 6 Focus group participant recruitment poster, 2017 (location and details removed)

Report Supplementary Material 7 Environmental audit information letter to participants, 2013–15

Report Supplementary Material 8 Environmental audit consent form for participants, 2013–15

Report Supplementary Material 9 Focus group participant information sheet, 2015 and 2017

Report Supplementary Material 10 Focus group consent form, 2015 and 2017

Supplementary material can be found on the NIHR Journals Library report project page (www.journalslibrary.nihr.ac.uk/programmes/phr/10300518/#/documentation).

Supplementary material has been provided by the authors to support the report and any files provided at submission will have been seen by peer reviewers, but not extensively reviewed. Any supplementary material provided at a later stage in the process may not have been peer reviewed.

List of abbreviations

CAPI	computer-assisted personal interview
CCA	cost–consequences analysis
CI	confidence interval
CPD	continuing professional development
CUA	cost–utility analysis
EQ-5D	EuroQol-5 Dimensions
EQ-5D-3L	EuroQol-5 Dimensions, three-level version
EQ-5D-5L	EuroQol-5 Dimensions, five-level version
FCS	Forestry Commission Scotland
GIS	geographical information system
HRQoL	health-related quality of life
ICER	incremental cost-effectiveness ratio
INS	Inclusion of Nature in Self
IPAQ	International Physical Activity Questionnaire
IPAQ-SF	International Physical Activity Questionnaire – Short Form
ITT	intention to treat
MET	metabolic equivalent
MRC	Medical Research Council
NICE	National Institute for Health and Care Excellence
NIHR	National Institute for Health Research
OR	odds ratio
PA	physical activity
PSA	probabilistic sensitivity analysis
PSS	Perceived Stress Scale
QALY	quality-adjusted life-year
SD	standard deviation
SE	standard error
SIMD	Scottish Index of Multiple Deprivation
SSC	study steering committee
SWEMWBS	Short Warwick–Edinburgh Mental Well-being Scale
WHO	World Health Organization
WIAT	Woods In and Around Towns
WTP	willingness to pay

Plain English summary

Poor mental health is a major public health problem. Evidence suggests that natural environments, such as woodlands, can support or improve mental health.

The health impacts of physical improvements to the environment and community events designed to increase people's use and enjoyment of woods in and around towns in Scotland were examined. Three woodlands that had received interventions as part of Forestry Commission Scotland's Woods In and Around Towns (WIAT) programme and three similar woodlands that had not were studied. Methods included doorstep surveys of community members, walks with local people to assess their woodland quality and other discussions with planners and locals.

It was found that the WIAT projects did not help to reduce people's levels of stress in those communities; in fact, their stress levels went up. This is difficult to explain; factors outside those studied may have influenced stress levels. There was no change in people's general health and quality of life. However, the WIAT projects made a small difference to how often people visited natural environments and people in these communities who visited natural environments were also likely to be less stressed than those who did not visit natural environments. The WIAT project communities also reported that their moderate physical activity levels had increased somewhat. When members of the local community were asked about the WIAT changes, they reported that they appreciated physical improvements to the environment and ranger-led activities but they had concerns about longer-term maintenance and antisocial behaviour.

This study showed that WIAT projects are low cost. However, without any benefits to overall health found immediately after the interventions, they cannot be counted as cost-effective.

Scientific summary

Background

High prevalence of poor mental health is a major public health problem in the economically developed world. Approximately 27% (83 million people) of the adult population in the European Union experienced at least one mental health disorder in the past year. The economic cost of poor mental health is high. In Scotland, where this project was based, this cost has been estimated at £10.7B.

Environmental influences on health, including mental health, are of particular interest because of their potential to affect large numbers of people. Observational and experimental studies have found associations between access to natural environments and a range of physical and mental health benefits. However, there is also evidence that, within certain distance parameters, quality may be more important than proximity. There is varying evidence on whether the health effects of proximity to natural environments are stronger in men or women.

The present evidence base on the population-level health effects of exposure to natural environments is largely observational and tells us little about how changes in access to natural environments improve health, or how those changes should best be achieved. For instance, it is unclear whether the provision of natural environments or the promotion of opportunities to access these environments matters most. This evidence gap provided the rationale for this study.

The research took advantage of a rare opportunity for a prospective study. Through its Woods In and Around Towns (WIAT) programme, Forestry Commission Scotland (FCS) planned a set of physical and social interventions in deprived communities to enhance public access to natural environments. The study treated these interventions as a quasi-experiment and investigated their impact on mental health at a community level over time.

Objectives

The study's main objective was to evaluate the health impacts of interventions that sought to increase community use of local woodlands. Our research questions were:

- What is the impact of the WIAT programme of interventions on mental health (particularly levels of stress) in the community?
- Is any impact on mental health associated with changes in engagement with woodland or other natural environments after implementation of the WIAT interventions?
- Are changes to the physical woodland environment sufficient to have an impact on mental health and/or woodland awareness and use by the community, or are organised activities and other promotional initiatives also required?
- What is the impact of the intervention on other health and well-being outcomes [i.e. physical activity (PA) levels, connectedness to nature and community cohesion]?
- What is the impact of the intervention on length and frequency of visits to natural areas and local woods, experience of local woods, awareness of them, activities undertaken there and visual contact with woodland?
- Are there gender differences in the impacts of the interventions?
- Are there differences in patterns of woodland use, and in impacts of the interventions, in accordance with distance of woodlands from participants' homes; is there any distance threshold for impacts?
- What are the cost consequences of each stage of the intervention in relation to the study outcomes?

Methods

The study was a controlled, programme-level evaluation of the WIAT intervention. The research design was quasi-experimental and included three intervention and three matched control sites as part of a longitudinal, mixed-methods study. Repeat cross-sectional surveys were undertaken of individuals resident in intervention and control communities, with three waves of data collection to assess health impacts. A longitudinal cohort of participants (seen at two or three waves) was nested within the cross-sectional surveys, the size of which was determined by the extent to which we obtained repeat responses. The study also tracked the quality and cost of environmental changes and promotional activities in the woodlands, the local communities' perceptions of these interventions and their impact on primary and secondary health outcomes.

The study contained six main components:

1. A preliminary survey of all potentially WIAT-eligible woodlands and their associated communities, using FCS maps and site visits, to identify sites appropriate for intervention starting in 2012/13 and for which comparable control woodlands and communities could be identified.
2. A record of the environmental and social interventions planned and implemented by FCS under their WIAT programme, including the costs involved at all stages.
3. A core survey of the local community in each site, undertaken before and after each of the two phases of WIAT intervention, to record the intervention's impact on health and well-being outcomes, perceptions and use of local woods and green space.
4. Audits of the woodlands and associated neighbourhood environment, by expert auditors and by community members, in both winter and summer, before and after each phase of the intervention, to evaluate any physical change at each site.
5. A qualitative study of a subsample of core survey and woodland audit participants from each local community to elicit an understanding of the experience of the intervention and perceptions of its effectiveness.
6. An economic evaluation of the intervention and any associated health outcomes identified.

The interventions

Phase 1 (physical interventions) took place over 8 months and included (1) clearing shrubs, (2) installing fences and gates, (3) creating boardwalks and paths and (4) adding signage.

Phase 2 (social interventions) started 4 months after the physical interventions were completed and took place over 9 months. Examples include led walk programmes, family fun days, sculpture, sport activities and special event days, targeting a range of different age groups.

Measures used in the core survey

The primary outcome was a measure of stress, assessed using the Perceived Stress Scale (PSS).

The main secondary outcome measures used were:

- mental well-being [as measured by the Short Warwick–Edinburgh Mental Well-being Scale (SWEMWBS)]
- self-reported PA levels [as measured by the International Physical Activity Questionnaire – Short Form (IPAQ-SF)]
- self-reported visits to the local woodland site
- self-reported visits to other local green spaces
- perceptions and experiences of the local woodlands

- emotional connection to the natural world [as measured by the Inclusion of Nature in Self (INS) scale]
- perceived restorativeness of the woodland environment
- self-reported health-related quality of life (HRQoL) [as measured by the EuroQol-5 Dimensions (EQ-5D)]
- perceptions of the local neighbourhood and social cohesion
- a range of sociodemographic variables.

Study participants recruited and analytical methods

The core community survey recruited individuals aged ≥ 16 years living in the intervention and control communities within 1.5 km of the relevant woodland site. Selection used a random sampling approach, stratified in accordance with distance from the WIAT-eligible woodlands. After data cleaning and checking, the survey produced a cross-sectional sample of 5460 participants (wave 1, $n = 2117$; wave 2, $n = 1672$; wave 3, $n = 1671$), labelled panel A. The survey contained a nested longitudinal cohort of 609 participants (wave 1, $n = 609$; wave 2, $n = 350$; wave 3, $n = 402$), labelled panel B. Panel B was less representative than panel A but had the virtue of reflecting change in the same individuals at baseline and after the interventions. Approaches to quantitative analysis included an overall effect estimate based on intention to treat (ITT) and, subsequently, a closer inspection of the intervention effect on our primary outcome (perceived stress). This considered the differential impact of the WIAT programme as a function of three main factors: (1) engagement with the woods (physical and visual), (2) gender and (3) distance to the woods.

Community members were also recruited to undertake 6-monthly environmental audits at all sites, each winter and summer between 2013 and 2015. Participants at each site contributed 256 community-led audits in total, alongside expert audits by landscape professionals.

Community members in the three intervention sites were also recruited to participate in post-intervention focus groups or interviews in 2015 or 2017 ($n = 34$). Thematic analysis of the transcripts informed interpretation of findings.

Economic analysis considered the costs of the interventions against HRQoL outcomes. Cost–consequences and cost–utility analyses were undertaken, along with a sensitivity analysis, and the results of all simulations were combined to give incremental cost-effectiveness ratio (ICER) results.

Results

Our findings for the primary outcome measure showed that stress (as measured by the PSS) increased significantly in the intervention group and marginally decreased in the control group. Multilevel regression models showed a differential impact between intervention and control at survey wave 3 in panel A [B (unstandardised coefficient) 3.58, 95% confidence interval (CI) 2.85 to 4.31; $p < 0.001$] and in panel B (B 3.03, 95% CI 1.54 to 4.52; $p < 0.001$). Mental well-being results showed a similar differential impact, with a decline in SWEMWBS score by wave 3 for panel A (B –0.57, 95% CI –1.10 to –0.03; $p < 0.05$) and panel B (B –1.65, 95% CI –2.73 to –0.57; $p < 0.01$). Using the same analytical approach, we found no significant change in HRQoL (EQ-5D) associated with the intervention.

The differential in stress between intervention and control was lower or non-significant in those who visited woodlands and other natural environments in the previous year (panel A, B 1.9, 95% CI 0.8 to 3; $p < 0.001$; panel B, B 0.64, 95% CI –1.6 to 2.88; $p = 0.57$), whereas for SWEMWBS there was a positive differential for this group in panel A by wave 3 (B 0.91, 95% CI 0.13 to 1.68; $p < 0.05$). The increase in PSS scores and decrease in SWEMWBS scores associated with the intervention was strongly evident in those who had not made such nature visits, suggesting that factors other than the WIAT intervention lie behind the mental health patterns observed.

Measures of PA (as measured by the IPAQ-SF) showed positive association with the intervention for moderate levels of PA (panel A, *B* 249.2, 95% CI 58.25 to 440.1; $p = 0.01$; panel B, *B* 559.3, 95% CI 211.3 to 907.2; $p = 0.002$) and overall PA (panel B, *B* 861.5, 95% CI 106.5 to 1616.4; $p = 0.025$). This compared favourably with the control group, in which levels of PA declined over time.

The intervention was also associated with increased INS score (panel A, *B* 0.39, 95% CI 0.2 to 0.57; $p < 0.001$) and social cohesion (panel A, *B* 0.5, 95% CI 0.29 to 0.70; $p < 0.001$) by wave 3 but these findings were significant for panel A only.

The intervention did not show a significant association with length and frequency of visits to the specified local woods. However, there was a significant association with undertaking nature visits more generally, compared with control sites, in both panels [panel A, odds ratio (OR) 2.69, 95% CI 1.9 to 3.81; $p < 0.001$; panel B, OR 2.77, 95% CI 1.45 to 5.29; $p < 0.001$]. This translated into a predicted increase of 6% in intervention site participants visiting natural environments, compared with a drop of 11% in the control site.

Awareness of the local woods also increased significantly for the intervention group (panel B, OR 3.39, 95% CI 1.72 to 6.67; $p < 0.001$). For those who visited their local woods (a minority of participants), there was a significant increase in going for a walk in the woods by wave 3 (panel A, OR 3.3, 95% CI 1.73 to 6.29; $p < 0.001$) and for walking with family and/or friends by wave 2 (panel A, OR 3.42, 95% CI 1.37 to 8.56; $p < 0.01$). For measures of experience of the woods associated with attention restoration theory, we found a significant association between the intervention and 'being away' and 'fascination' by wave 3 for both panels ['being away', panel B, *B* 2.72, 95% CI 1.95 to 3.49; $p < 0.001$].

Although our results showed that, on average, women were consistently associated with higher levels of stress than men, there was no significant difference in stress levels by gender.

Differences in stress between the intervention and control groups were largest in those living furthest from the woods (501–750 m and 751–1500 m), with significantly higher stress in both panel A and panel B for participants in these categories. In panel B, increases in stress levels were not significantly different between control and intervention site participants living within 500 m of their local woodlands.

The environmental audit results showed a significant difference between intervention and control site scores at each time point, both for community ($p < 0.001$) and for expert audits ($p < 0.001$). The interventions were perceived as significantly enhancing the quality of the intervention woodlands compared with baseline, and this was true regardless of seasonality. By summer 2015, after both phases of the intervention were completed, the intervention sites were considered to be of significantly higher quality than the control sites. However, for the community auditors (but not the expert auditors), this had also been true at baseline.

The qualitative analysis of focus groups and interviews suggests that the positive changes in intervention sites noted by community-led audits were highly appreciated by community members, although these were often participants who already visited the woods regularly. Positive responses to the intervention included walking, appreciation of wildlife and nature (especially for children) and enjoyment of peace and quiet. There was also evidence of positive social engagement and community benefits. Negative comments largely focused on vandalism, litter and dog faeces, overgrown vegetation and deterioration of footpaths that reflected a lack of maintenance after the interventions were completed. Overall, there was considerable consistency between comments made by community site auditors and the focus groups/interviews.

The total cost of the WIAT interventions was £241,667 across the estimated eligible population on whom the programme had an impact ($n = 20,472$). This resulted in an average cost of £7.68 (95% CI £7.67 to £7.69) for the physical intervention (wave 2) and £11.80 (95% CI £11.79 to £11.82) for both physical and social interventions (wave 3). Because no significant associations between the intervention and improvements in EQ-5D score were found, WIAT's cost-effectiveness cannot be demonstrated. The cost–utility analysis in panel A reveals an ICER of £935 (95% CI £399 per QALY to dominated, thus higher cost and lower QALY

than the control) in wave 2 for the physical intervention and an ICER of £662 (95% CI £206 per QALY to dominated) in wave 3 for both social and physical interventions. This illustrates that, given the modest cost of the interventions based on the average per person in the eligible population, WIAT interventions would need to have only a small impact on HRQoL to show cost-effectiveness.

Contributions of the study

To our knowledge, this study is the first of its kind: a prospective study in which planned interventions to enhance urban populations' access to natural environments provided a 'natural experiment' and health impacts of the interventions were evaluated at a community level over time. Our evaluation was enhanced by several factors, including primary data collection, the embedded longitudinal component and a mixed-methods approach.

The study is underpinned by a clear theoretical model and the findings offer some support for certain pathways indicated in the model between interventions in the natural environment and health outcomes.

Conclusions

- The significant increase in stress outcomes associated with intervention sites cannot be adequately explained by data from our mixed-methods approach and may be attributable to external influences beyond this study.
- Our evidence suggests that other, significantly positive outcomes may be at least in part attributable to the interventions, although we cannot exclude external influences.
- The economic evaluation illustrated the requirements for WIAT to show cost-effectiveness in relation to HRQoL. Longer-term interventions and post-intervention evaluation might be needed before any such outcome is likely.
- We recommend increasing the number of sites included in such a study – that is, in which natural experiments do not allow for random allocation of participants to different treatments and the cost of primary data collection is high. Such an approach might, for example, use routinely collected data to undertake a whole-programme evaluation of WIAT.

Funding

Funding for this study was provided by the Public Health Research programme of the National Institute for Health Research.

Chapter 1 Background

This section outlines the wider context and background against which the study was developed. The study's public health focus (mental health) is presented and the intervention it evaluated is introduced.

Context

High prevalence of poor mental health is a major public health problem in the economically developed world. Approximately 27% (83 million people) of the adult population in the European Union experienced at least one mental health disorder in the past year.[1] The economic cost of poor mental health is high. In Scotland, where this project was based, this cost has been estimated at £10.7B.[2] Improving mental health and well-being is a public health priority.

Environmental influences on health, including mental health, are of particular interest because of their potential to affect large numbers of people.[3] Epidemiological investigation and public health policy have long understood the environment primarily in terms of threats to human health; however, there is now growing interest in the salutogenic properties and capacities of environments – that is, in the potential for environments to maintain and improve health.[4] Good evidence from both individual- and population-level studies suggests, for example, that contact with natural environments and green spaces, such as parks, woodlands and river corridors, brings health benefits.[5–7]

How do natural environments affect health? Three principal mechanisms have been proposed.[8] First, they may be conducive to physical activity (PA), for which health benefits are well proven.[9] Second, they may foster and support social contact, again for which there is evidence of health benefit.[10,11] Third, contact with natural environments per se may reduce stress, improve well-being and promote immune response.[12–14] This direct effect of natural environments on human health operates, inter alia, via psychoneuroendocrine pathways and has been demonstrated in both laboratory and field experiments.[7,12,15] Empirical evidence for such psychophysiological benefits is supported by well-developed theories about this effect's origin, such as the hypothesis that it is a psychoevolutionary response to environments that have proved favourable to humans.[16–18] The balance of evidence currently suggests that the psychophysiological responses may be the most important of the three mechanisms, although they may be additive or supra-additive.[8] In addition, there is evidence that greener environments are less polluted environments in terms of air quality, either because vegetation removes pollutants from the air or because a greener environment has fewer pollution sources within it.[19,20]

How useful could these health effects be for *population* health? Observational studies have found associations between access to natural environments and mortality rates for diseases in which stress, immune function and PA play a role in aetiology (see, for example, Maas *et al.*,[21,22] de Vries *et al.*[23] and Coutts *et al.*[24]). Studies in the UK show a typical reduction in risk of mortality from cardiorespiratory disease of 5% to 10% in urban-dwelling populations with good access to natural environments compared with those with poor access.[25,26] In Denmark, Stigsdotter *et al.*[27] found reported levels of stress to be some 40% lower among those with good access to natural environments (≤ 300-m distance) than those with poor access (> 1 km distance). A number of studies have shown greater use of green space when it is more proximate.[28–30] However, there is also evidence that, within certain distance parameters, quality may be more important than proximity.[31] The positive impacts of access to natural environments appear particularly beneficial for deprived urban populations and this might be one explanation for the evidence that socioeconomic health inequalities appear narrower among urban populations with greater access to natural environments.[25] It is important to note, however, that results from observational studies vary by individual characteristics; in particular, it appears that effects may be greater for men than for women.[26] There is currently no clear empirical evidence as to why this should be, although it is hypothesised that it

might be attributable to differences between men and women in the frequency, duration and mode of access to natural environments.

The present evidence base on the population-level health effects of exposure to natural environments is, then, largely observational and is therefore subject to the biases and threats from confounders that characterise observational designs. This evidence base also tells us little about how potential changes in access to natural environments improve health or, perhaps more importantly, how those changes should best be achieved. We do not know, for instance, if it is the provision of natural environments or the promotion of opportunities to access these environments that matters most, or if both are equally important. This evidence gap provided the rationale for this study.

The research took advantage of a rare opportunity for a prospective study. Through its Woods In and Around Town (WIAT) programme, Forestry Commission Scotland (FCS), the Scottish Government's forestry advisor and regulator and the public body that manages Scotland's forests and woodlands, planned a set of physical and social interventions in deprived communities to enhance public access to natural environments. The study treated these interventions as a 'natural experiment'[32] and investigated their impacts on mental health, particularly perceived stress, at a community level over time.

Woods In and Around Towns

Woods In and Around Towns is a programme delivered by FCS that targets woodlands near socially deprived urban communities. It operates to improve and promote local woods as safe and accessible places for enjoying the outdoors.[33] WIAT aims to increase local residents' contact with woodlands that are situated within 1 km of settlements with a population of at least 2000 people, thus enhancing well-being and quality of life in urban Scotland.

In aiming to increase local residents' contact with their local woodlands, WIAT aims to improve mental health and well-being, including stress regulation. FCS committed > £70M to WIAT between 2005 and 2015. It delivers a suite of physical and social interventions within targeted woodlands. Physical interventions consist of physical changes to enhance sustainable management of the woodlands and improve onsite recreation facilities (new paths, signage, entrances, etc.). Social interventions consist of a programme of publicised and facilitated community-level activities/events (e.g. guided walks, natural play and woodland-based classes for school children) that aim to promote the woodlands and increase use. The social and physical interventions delivered in a given woodland are particular to the needs, challenges and interests of that woodland and surrounding community. WIAT represented a rare and valuable opportunity to carry out a prospective evaluation of the health impacts of change in, and promotion of, woodland environments near deprived communities.

Members of the study team had previously investigated impacts of WIAT interventions in a pilot study completed between 2006 and 2009 in the city of Glasgow. That study focused on one wooded green space that received WIAT interventions and a matched comparison green space that did not.[34] Using a repeat, cross-sectional survey ($n = 100$) of residents living within 500 m of their local green space, impacts on patterns of use, PA, perceived quality of life, perceptions of the neighbourhood and perceptions of woodland/green space environments were explored.[34] The study revealed that the interventions had a positive impact on use patterns and were associated with improved quality of life and enhanced perceptions of the neighbourhood and woodlands; these are factors that might influence health outcomes.[34]

The current study provided an opportunity to investigate these relationships further and, if established, explore whether or not they translated into changes in health and well-being. Within this study, therefore, we evaluated the impacts of physical and social interventions delivered by FCS as part of the WIAT programme within three separate woodlands located in the Central Belt of Scotland. These interventions targeted approximately 38 ha of woodland in total, delivered some 3500 m of new and upgraded path,

new seating areas and signage, a restored water feature, repaired fences, tree works and > 60 community engagement activities including photography workshops, health walks and bulb-planting days.

Research aims and objectives

Ultimately, the study aimed to provide robust and generalisable evidence on the impact on mental health of an intervention designed to enhance, and increase engagement with, natural environments. To provide a complete assessment of the WIAT interventions, the study aimed to evaluate the effects of the interventions, the functioning of the interventions[35] and the interventions' value for money through linked quantitative, qualitative and economic evaluations.

The key research objective and questions that steered the study were as set out below.

The study's main objective was to evaluate the health impacts of an intervention that enhanced woodland environments in deprived communities and sought to increase community engagement with these woodlands. This aim was captured in the following primary research question:

- What is the impact of the WIAT programme of interventions on mental health (particularly as measured by patterns and levels of perceived stress) in the community?

Several secondary research questions also structured the study:

- Is any impact on mental health associated with a change in levels of engagement with woodland or other natural environments (physical and/or visual) after implementation of the WIAT intervention?
- Are changes to the physical woodland environment sufficient to have an impact on mental health and/or woodland awareness and use by the community, or are organised activities such as led walks and other promotional initiatives also required?
- What is the impact of the intervention on other health and well-being outcomes (i.e. PA levels, sense of connectedness to nature and community cohesion)?
- What is the impact of the intervention on length and frequency of visits to natural areas and local woods, experience of local woods, awareness of them (knowledge of their qualities and availability for use), activities undertaken there and visual contact with woodland?
- Are there gender differences in the impacts of the interventions?
- Are there differences in patterns of woodland use, and in impacts of the interventions, in accordance with distance of woodlands from participants' homes, and is there any distance threshold for impacts?
- What are the cost consequences of each stage of the intervention (including time input from FCS rangers) in relation to the primary and secondary outcomes of the study?

Literature review

This study was informed by a review, summarised here, of the relevant literature focusing on the few intervention studies that have considered the effects on mental health of physical changes to natural environments and/or exposure to natural environments.

There is accumulating evidence for the beneficial effects of green space on mental health.[36] Multiple studies have found associations between living in or near green environments and/or visiting green environments and improved mental health, lower levels of stress, depression, anxiety and psychological distress and higher levels of well-being and vitality.[27,37–43] Although the precise attributes of green space associated with these health benefits, and the relative importance of different attributes, requires further research,[36,44] studies have identified tree cover, tree canopy density, neighbourhood greenery, visible grass and trees,[45,46] the quality of green space and its sensory and spatial characteristics[47–49] as important. Different segments of the population experience differential health benefits from these and other attributes, with evidence indicating that gender, age, ethnicity and socioeconomic status may mediate the effect.[36] For example,

a significant relationship has been identified between access to 'serene' green space (i.e. a 'holy', safe, calm, undisturbed, silent green environment) and improved mental health in women but not in men.[40]

It is rare for insights into the effect of natural environments on mental health to derive from studies that assess the impacts of natural environment interventions. This may in part be because natural environment interventions rarely focus on impacts on mental health. The World Health Organization (WHO) recently issued a call across European professional and city networks for case studies of urban green space interventions.[50] Of the 48 complete submissions received, sent in by municipal authorities, public agencies and third-sector organisations, only five considered impacts on mental health.[51] Also relevant might be the finding that studies of the impacts of natural environment interventions that deliver physical change rarely focus on changes in mental health; instead, changes in PA or visits to green space are the usual concern.[44] A recent systematic review of interventions that delivered physical changes to urban green spaces identified 38 relevant studies, but just three measured mental health outcomes: two considered self-reported stress levels[52,53] and one considered self-reported depressive symptoms.[54] Those studies considering stress levels found that residents reported lower levels of stress in areas where vacant urban lots had been cleaned up and 'greened' (trees and grass planted, land graded, low wooden perimeter fences installed)[52] and, although not constituting a significant decline, reduced levels of stress in areas where green storm water infrastructure had been installed.[53] In the study that considered depressive symptoms, highlighting the important point that studies do not universally identify a positive relationship between natural environments and improved health, a significant increase in depressive symptoms was identified in adolescents (adolescents and adults were studied) in areas that had received park-based and greening interventions.[54]

Studies of the impacts of natural environment interventions that deliver physical change suffer from various methodological limitations that curtail the insights they afford.[44] Studies often operate short follow-up periods, limiting the potential to assess longer-term impacts.[44] Details of sample size calculations are rarely provided and many studies are underpowered.[44] Studies lacking an appropriate sample size calculation are at increased risk of type II errors when the sample is too small to detect an effect. Few studies have considered the economic implications of interventions and studies often provide incomplete accounts of the interventions evaluated, neglecting measures of their implementation (e.g. dose, fidelity, reach).[44]

Compared with the number of studies that have considered the impacts on mental health of interventions that deliver change in natural environments, far more studies have evaluated the effects on mental health of interventions that focus on exposure to natural environments. A recent systematic review of trials that compared the effects on well-being of outdoor exercise initiatives with indoor initiatives identified 11 relevant studies and all measured some aspect of mental well-being, usually mood.[55] These studies indicated that, relative to exercising indoors, exercising in natural environments was associated with decreases in tension, confusion, anger and depression, greater feelings of revitalisation and positive engagement and increased energy, although feelings of calmness appeared to reduce.[55] A similar systematic review, which focused on studies that compared the impacts on health or well-being of exercise completed in natural environments with exercise completed in 'synthetic' environments, identified 25 relevant studies and 16 of these measured aspects of mental well-being.[56] These studies indicated that exercising in natural environments was associated with beneficial effects on several dimensions of mental health, including measures of anger, fatigue and depression/sadness.[56] However, various methodological limitations restrict the insights afforded by these types of studies.[56] Studies often focus on single exposures to natural environments and effects are often assessed immediately following exposure.[56] As a result, longer-term impacts, and the impacts of repeat exposure, are not considered.[56] Study participants tend to be college students, adult males and physically active adults, limiting the potential to extrapolate to wider populations.[56] Finally, within some studies it is unclear if the selected 'natural' environments are sufficiently 'green' to provide a test of the effect of 'nature' on health.[56]

To address gaps and deficiencies in the evidence base, such as those discussed here, there is a clear need for further formal assessments of natural environment interventions that deliver physical change.[44] This study, in seeking to evaluate a natural environment intervention that delivered change in community woodlands, was conceived to help address this need.

Chapter 2 Study design and methods

This chapter describes the study's overall research design and presents the approach and methods employed to address each of the research questions outlined in *Chapter 1*. It involved both quantitative and qualitative methods and considerable community and stakeholder engagement. This multimethod approach allowed us to identify the outcome of the interventions in relation to our key health, well-being and quality-of-life measures (see *Chapter 3*). We explored community perceptions of the environment affected by the WIAT interventions (see *Chapter 4*) and undertook an economic evaluation (see *Chapter 5*) of the interventions. The methods used for each are described in turn.

A high-level evidence-based logic model (*Figure 1*) that hypothesised how the interventions would affect health underpinned and orientated the study. It is an adapted version of the model for this study published by Silveirinha de Oliveira *et al.* in 2013.[57] This theory posited that the physical changes to the woodlands would make them more accessible, more aesthetically pleasing and safer, and the social interventions would increase awareness of, and engagement with, the woodlands as well as social interactions among community members. Collectively, this would lead to individuals visiting the woodlands more often and taking greater pleasure in views of and use of the woodlands. As a result, there would be measurable reductions in self-reported levels of stress (our primary outcome measure). Other hypothesised pathways to this outcome included increased levels of PA, increased feelings of connectedness with nature and better community cohesion.

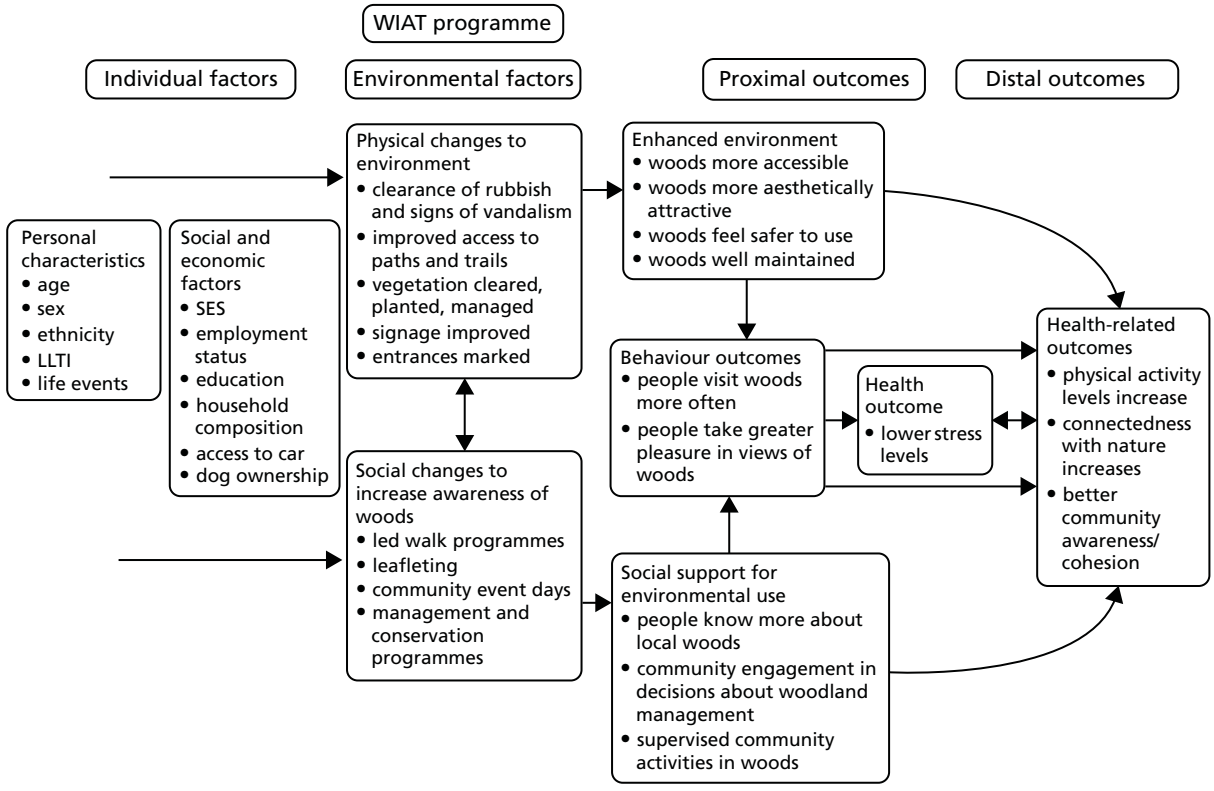

FIGURE 1 Hypothesised impact pathways of the WIAT intervention programme. LLTI, limiting long-term illness; SES, socioeconomic status. Adapted with permission from Silveirinha de Oliveira *et al.*, 2013.[57] This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: http://creativecommons.org/licenses/by/4.0/.

Overall research design

The study was a controlled programme-level evaluation of the WIAT intervention. The research design was quasi-experimental and included three intervention and three matched control sites. The WIAT intervention was treated as a natural experiment.[32] The study design included repeat cross-sectional surveys of individuals resident in intervention and control communities, with three waves of data collection to assess health impacts. A longitudinal cohort of participants (seen at two or three waves) was nested within the cross-sectional surveys, the size of which was determined by the extent to which we were able to obtain repeat responses. The longitudinal mixed-methods study also tracked the nature and cost of environmental changes in woodlands and promotional activities that took place, the local communities' perceptions of these interventions and the interventions' impact on primary and secondary health outcomes.

The study contained six main components (*Figure 2*):

1. A preliminary, geographical information system (GIS)-based assessment of all potentially WIAT-eligible woodlands and their associated communities, using both FCS maps and (in the final stages of site choice) site visits, to identify sites appropriate for intervention starting in 2012/13 and for which comparable control woodlands and communities could be identified in each case.
2. A record of the environmental and social interventions planned and implemented by FCS, under the WIAT programme, including the costs involved at all stages, to ensure that we could identify sites that had not been subject to recent WIAT intervention prior to the commencement of this study.
3. A core survey of the local community in each site, undertaken before and after each of the two phases of WIAT intervention, to record the intervention's impact on health and well-being outcomes, perceptions and use of local woods and green space, and assessments of the local neighbourhood and the interventions.
4. Audits of the woodlands and associated neighbourhood environment, both by expert auditors and by local community members, in both summer and winter, before and after each phase of the intervention, to evaluate any changes in the physical characteristics of each site.
5. A qualitative study of a subsample of core survey and woodland audit participants from each local community to elicit an understanding of the experience of the intervention and perceptions of its effectiveness.
6. An economic evaluation of the intervention and any associated health outcomes identified.

Figure 3 shows the time scale for the data collection components 3, 4 and 5 listed above against the time scale of the WIAT interventions.

Study setting

Six woodland sites (three intervention and three control sites), and associated communities, were included in the study. They were located within the Scottish Lowlands Forest District, a district that covers the Central Belt of Scotland, extending from the west to the east coast and including the major conurbations of Glasgow and Edinburgh. The National Records of Scotland show that, of the 5.37 million people living in Scotland in mid-2015, the Central Belt of Scotland contained > 3.3 million of those people. This highly urbanised part of Scotland, including Greater Glasgow, Renfrewshire, North Ayrshire, North Lanarkshire, Falkirk, the Lothians, Edinburgh and Fife, also contains the majority of the most deprived populations.

Site selection

The woodlands and associated communities were chosen from among those that met WIAT inclusion criteria. At the time of site selection, these required woodlands to lie within 1 km of a settlement of at least 2000 people, for the woodland to cover a minimum of 1 ha and at least 40% of the land had to have tree cover. Furthermore, the WIAT programme targets woodlands in areas of high deprivation.

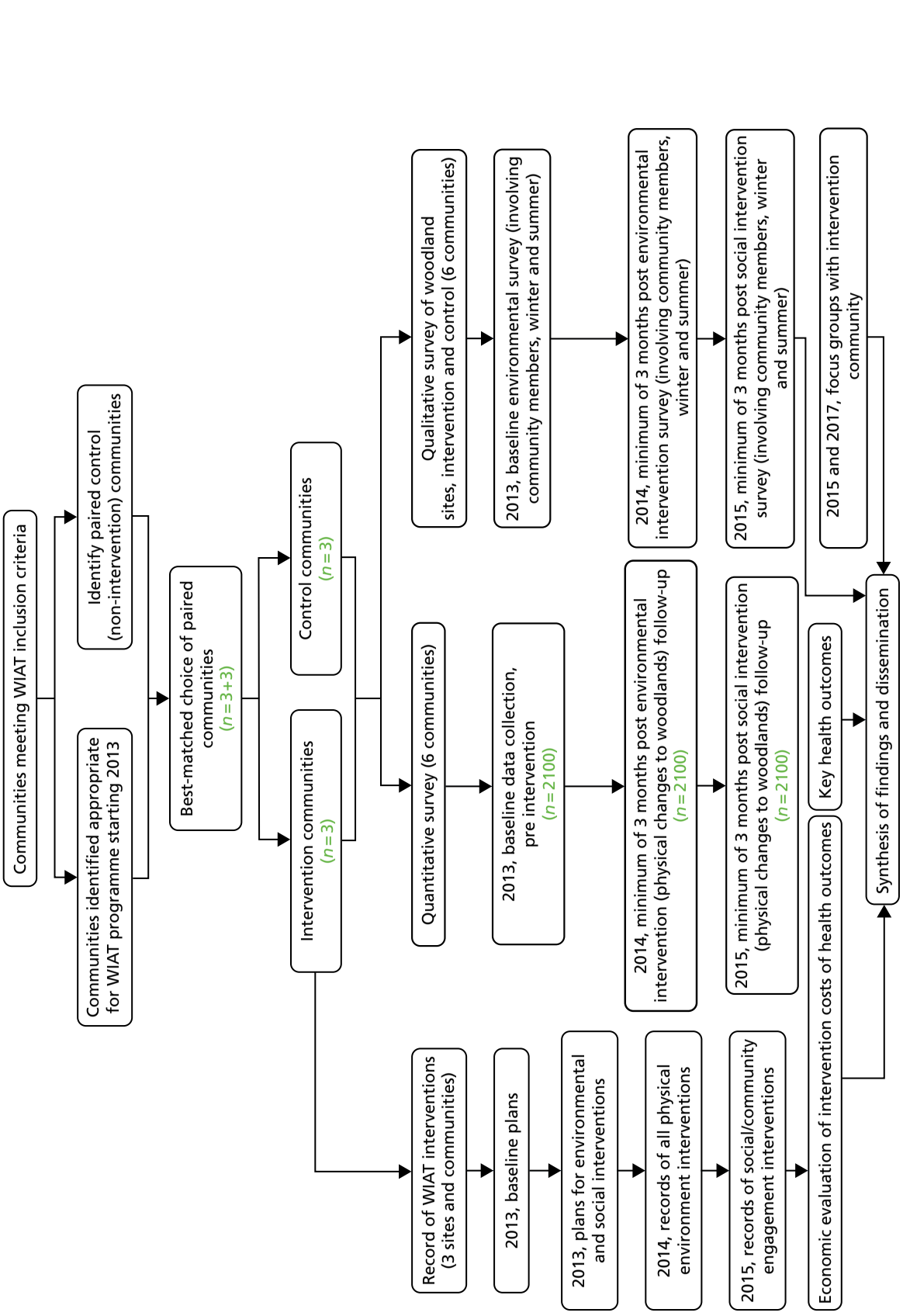

FIGURE 2 Study components and sequence.

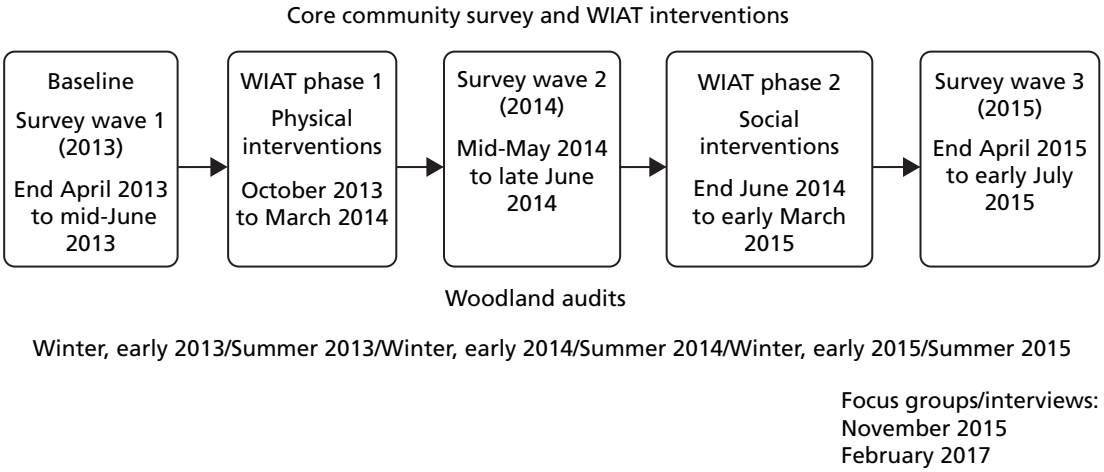

FIGURE 3 Time scale of data collection and WIAT interventions.

Our site selection further developed these criteria to choose sites that satisfied the study requirements, including the need to match sites ready for intervention as closely as possible with control sites in terms of a number of environmental and demographic characteristics. The process was as follows.

1. Sites were chosen within the worst 30% of socioeconomic deprivation in Scotland as measured by the Scottish Index of Multiple Deprivation (SIMD).[58]
2. At least 50% of the woodland area had to be within 1.5 km of an urban population of at least 2000 people. We expanded the definition of community within range of woodlands to 1.5 km to ensure an adequate settlement size for sampling purposes and to allow for any effect of distance to be assessed.
3. Woodlands had to have a minimum size of 4 ha (this was deemed more typical of WIAT sites in practice than the FCS minimum criterion of 1 ha for WIAT eligibility) and at least 40% of the land had to have tree cover. After the application of steps 1, 2 and 3, 40 sites were identified as potential candidates. The selection process was narrowed further by assessing the physical qualities of both woodlands and surrounding communities. To do so, satellite and panoramic images via Google Earth (Google Inc., Mountain View, CA, USA) were used. Factors considered for this analysis included:

    i. The maturity and the degree of existing cover of the trees.
    ii. The height of residential buildings (because high-rise or tower block housing provides particular challenges in terms of access, we excluded areas with this housing).
    iii. The different ways of accessing the woodlands, including any major physical barriers to access.
    iv. The number of private or semi-private gardens as well as the quantity of trees there.

4. A final shortlist was presented to the FCS to assess the status of each site, potential issues, previous grants and interventions. Woodland sites that had received FCS investment or direct promotion within the previous 5 years were discarded. This resulted in a shortlist of 10 sites from which to choose for the study.
5. Several visits to the shortlisted sites were conducted by researchers and members of the FCS to examine whether or not the characteristics of the sites were fully consistent with the desk-based analysis.
6. Six sites were chosen in December 2012, assigned to the intervention or control group and paired (one each of intervention and control) based on various socioeconomic and demographic characteristics of individuals living in the surrounding communities (*Table 1*). Three sites were assigned to the intervention group and the remaining three to the control group (*Tables 2a* and *2b*). The intervention sites of each matched pair were chosen based on their readiness for management agreements to be obtained (see point 7), as there was little time for lengthy negotiations on ownership, access and use.
7. Management agreements were prepared between the FCS and the local authorities involved to ensure that no other interventions within the shortlisted sites took place during the time frame of the natural experiment, thus reducing confounding issues in the study design. These efforts also involved close consultation with private land owners as some of the chosen woodlands were not under full ownership of the relevant local authorities.

TABLE 1 Community characteristics used to match intervention and control sites

Characteristic				
Demographic	**Neighbourhood housing**	**Economic factors**	**Multiple deprivation**	**Health**
• Age profile • Mean age • Percentage of non-white residents	• Proportion of detached, semi-detached, terraced, flats/tenements • Building height	Income (number of income-deprived people)	SIMD[a]	• SMR[a] • Proportion of population being prescribed drugs for anxiety, depression or psychosis[a]

SMR, standardised mortality ratio.
a Data obtained at datazone level for the relevant output areas.

TABLE 2a Demographic characteristics of study sites

	Age, years (%)											Ethnicity
Site	0–9	10–14	15–19	20–29	30–44	45–59	60–64	65–74	75–84	≥ 85	Mean age (years)	Non-white (%)
Intervention A	12	8	8	10	21	17	7	11	4	1	39	1
Control A	14	9	8	10	22	17	6	9	4	1	37	0
Intervention B	12	7	7	11	22	16	9	13	4	1	40	1
Control B	11	9	8	12	22	21	5	7	4	1	37	2
Intervention C	16	9	8	13	24	16	4	7	3	0	34	1
Control C	15	9	9	14	23	18	3	5	4	1	34	1

Note
Percentages may not total 100 owing to rounding.

TABLE 2b Neighbourhood and health characteristics of study sites

	Neighbourhood housing type (%)					Economic and deprivation indicators		Health	
Site	Detached houses	Flats/ tenements	Semi-detached houses	Terraced houses	Other (e.g. caravan)	Income deprivation score[a] (%)	SIMD score[b]	SMR[c]	Depressed (%)
Intervention A	4	41	22	32	1	33	49	152	10
Control A	8	48	19	24	2	35	49	143	11
Intervention B	2	50	11	36	1	27	36	111	9
Control B	7	13	32	47	1	23	32	120	11
Intervention C	3	15	22	58	0	22	35	108	10
Control C	9	13	17	61	1	25	35	97	11

SMR, standardised mortality ratio.
a The proportion of the population who are in receipt of benefits related to low income.
b The scores are a weighted sum of scores for seven domains indicating relative deprivation: current income, employment, health, education, geographic access, housing and crime; the scores are obtained at datazone level for the relevant output areas.
c The area's actual number of deaths as a percentage of its expected number (100) for Scotland as a whole; data obtained at datazone level for the relevant output areas.
Note
Percentages may not total 100 owing to rounding.

The three matched pairs of sites were located in Glasgow City, Renfrewshire (two sites), North Lanarkshire, Midlothian and Fife. *Tables 2a* and *2b* show the community characteristics of the sites chosen and *Table 3* shows the characteristics of the eligible woodlands in each of these sites.

The Woods In and Around Towns interventions: environmental and social interventions

A record was kept of the interventions, which were planned and implemented in two phases. The aim was that FCS would follow typical procedures for WIAT programme interventions, although the study design placed additional constraints of timing on both phases of implementation.

Phase 1: environmental interventions

Phase 1 involved physical changes to the woodland environment, designed to facilitate better access to, and use of, the woods. The interventions took place simultaneously across the three intervention sites over a period of 6 months, between October 2013 and March 2014. As with all WIAT schemes, the interventions were responsive to local conditions and community needs and, therefore, followed WIAT principles but varied in the detail of their design and implementation. The WIAT interventions followed principles defined by FCS in its grant-aid schemes of that time (2010).[33] The FCS guide to developing interventions to enhance the woodland user experience[59] also informed the interventions to help ensure that a consistent approach was taken.

Researchers documented the physical state of the sites before and after the first intervention phase of the WIAT programme, undertaking regular checks of the environment in the field. In addition, FCS kept a systematic record of the plans, progress and completion of the works and noted feedback from the rangers involved in the projects as they progressed.

TABLE 3 Characteristics of study site woodlands

Site	Woodland overview
Intervention A	Total area: 8.5 ha (approximately). The intervention woodland is 5.9 ha, owned by Glasgow City Council; remaining area is in private ownership. Located on a hill – elevation begins at 25 m and rises to 42 m. Located between two deprived neighbourhoods. There are a few other nearby areas of green space, all separated from the site by main roads, including parks and woods
Control A	Total area: 4 ha (approximately). Mostly in private ownership. The control woodland is located between a deprived neighbourhood and a main road. Mostly flat, with some elevation on the south and west side, away from the road. A river runs through the woodland. There are a couple of other nearby areas of green space (a park and woods) separated by main roads
Intervention B	Total area: 24 ha (approximately). Forms part of a larger woodland that includes a further 11 ha of mature woodland (not part of the intervention site). Owned by Renfrewshire Council. Relatively level terrain (elevation 12 m). Located on the fringe of a deprived community separated from the housing by a sports centre and playing fields. There is only one other green space, at some distance to the south of the neighbourhood, beyond a main road
Control B	Total area: 16 ha. Mostly in private ownership. Varied landform including a steeply incised stream and gentle sloping areas. Located on the fringe of a deprived community beyond a local residential road. There is one additional nearby green space, a small park, plus a large golf course with woodland at some distance and beyond a main road
Intervention C	Total area: 5.8 ha. Owned by Midlothian Council. Sloping topography. Located next to a deprived community with housing on three sides. Additional nearby areas of green space include an open green space with some small woodland areas, separated from the site by a minor local road, and fields and small woodland strips further away
Control C	Total area: 11 ha (approximately). Owned by the Woodland Trust but leased to the GreenBelt Group (which manages green spaces). Mixed terrain including relatively flat areas and a very steep slope. Located between two deprived neighbourhoods. Additional nearby areas of green space include a woodland and further green space beyond main roads

The physical changes to each intervention site were:

- Intervention site A – upgrading main entrance with stone setts (paving blocks) and bollards (wooden posts to exclude vehicular traffic), surfacing a loop path (i.e. a path taking a more or less circular route to return to its starting point) (approximately 650 m), treeworks (trimming and clearing overgrown vegetation and tree branches), fence repair, installing two picnic benches, installing two benches and litter picking.
- Intervention site B – upgrading three entrances, surfacing a loop path (approximately 1900 m), treeworks (thinning trees and trimming and clearing overgrown vegetation and tree branches), installing two picnic benches; installing six benches, new signage, restoring pond and creating dipping platform and litter picking.
- Intervention site C – upgrading one existing entrance, creating one new entrance with stone setts, surfacing a loop path (approximately 990 m), non-surfaced path improvements, treeworks (felling and thinning trees and clearing overgrown vegetation and tree branches), installing one bench and litter picking.

Forestry Commission Scotland produced plans of the interventions and the researchers photographed the physical state of the sites before and after this phase of the WIAT programme. *Figures 4–6* show images of typical physical changes to each intervention site in this phase of intervention, all taken in winter months for ease of comparison. See *Appendix 1* for plans of the environmental interventions.

Phase 2: social interventions

Phase 2 involved social interventions via facilitated community engagement activities to advertise and promote woodland use. The social intervention started in June 2014 (4 months after the physical intervention was completed) and took place in the three intervention sites over a total period of 9 months, until March 2015. They were planned around typical interventions used in the WIAT programme and, as with the physical interventions, were responsive to local woodland and community characteristics and aimed to target a variety of different segments, including different age groups, within the community. Typically, they involved one or two forest rangers and up to 1 day of preparation.

Community members were invited to these activities by FCS using a variety of means to engage different groups via both targeted events [e.g. photography workshops, a continuing professional development (CPD) event for nursery teachers and assistants] and more general events aimed at the whole community. Public events were freely open to all and widely advertised, for example through posters on site, in local shops, libraries, health centres, schools, community council Facebook (Facebook, Inc., Menlo Park, CA, USA; www.facebook.com) pages and letter drops to people's homes.

FIGURE 4 Intervention site A before (above) and after (below) environmental interventions. Reproduced with permission from OPENspace.

FIGURE 5 Intervention site B before (above) and after (below) environmental interventions. Reproduced with permission from OPENspace.

FIGURE 6 Intervention site C before (above) and after (below) environmental interventions. Reproduced with permission from OPENspace and FCS.

The FCS rangers completed a form devised by the researchers for each activity undertaken to ensure that a systematic record was kept of the social intervention delivery and the participants engaged. This included a record of:

- the number of people involved
- the estimated age group of participants
- the participants' genders.

Table 4 summarises the 62 social interventions undertaken and the numbers of participants. For some public events the attendance was so high that only an estimate of numbers was possible. It should also be noted that those participating in some events might be the same people attending repeated sessions,

TABLE 4 Social interventions and numbers of participants

Social intervention (*n*)	Number of participants		
	Intervention site A	Intervention site B	Intervention site C
Public event (11)	168	272	80
Photography workshop (7)	8	10	6
Health walk (9)	14	43	n/a
Summer club (during school holidays) (8)	77	51	n/a
School/nursery school session (11)	108	46	n/a
Green gym[a] (11)	10	12	n/a
Community clean-up/litter picking (2)	n/a	n/a	20
Dog owners' event (2)	n/a	n/a	5
Nursery teachers' CPD session (1)	n/a	n/a	9
Total number of attendees	385	434	120

n/a, not applicable.
a Run by partner TCV (The Conservation Volunteers, Doncaster, UK).

so the numbers reported are not necessarily unique individuals but the sum of those attending any one event. Most activities attracted a reasonable balance of male and female participants, although school and nursery teachers and assistants were predominantly female and health walk participants were predominantly male.

Public events and those with school or nursery children included activities to introduce children and adults to the natural environment (e.g. 'The Secret Woodland', 'Magic in Your Woodlands', 'Winter Woodland Wonders', 'Meet the Critters', family fun day, a 'Scavenger Hunt', bulb planting). Art works were also created as part of the activities celebrated in public events (e.g. a wooden carving of a dragon at intervention site A and a woven willow sculpture of a deer at intervention site B).

Recording progress and monitoring of the Forestry Commission Scotland interventions

Forestry Commission Scotland recorded its plans and progress, including budgets and resource allocation for the study interventions, as part of normal WIAT procedures. Feedback included numbers of attendees and community engagement events, as described above, and comments from participants. For example, a participant at an intervention site B public event in September 2014 called 'Magic in Your Woodlands' noted 'Just wanted to say what a wonderful day the boys had. We stayed for over 4 hours'.

In addition, regular progress meetings took place between the researchers and FCS staff managing the interventions to discuss plans for the interventions, progress, any problems or delays, any additional engagement with the local community and current or potential site users and any feedback on the process of intervention implementation. The meetings also ensured that detailed records of the interventions for research purposes were maintained. In total, 12 meetings were held between May 2012 and November 2015, with meetings most frequent during the process of physical and social interventions. At the end of the interventions, a reflective workshop was held in May 2016 by an external researcher from Forest Research with the FCS project management staff to explore the FCS experience of undertaking the interventions and identify good practice and lessons learnt.[60]

The records of progress meetings with FCS show that the interventions were planned in accordance with standard WIAT procedures and both physical interventions (see *Appendix 1*) and social interventions were discussed and agreed by FCS staff and notified to the researchers in advance of implementation. It was, in particular, agreed that, so far as possible, the interventions would be typical of the WIAT programme,

drawing on a relatively modest budget rather than being singled out for additional levels of funding or other resources (minutes of progress meeting on 11 June 2013).

The implementation of the physical interventions involved both Forest Enterprise staff and contractors to undertake the construction work, as is typical of WIAT projects. The progress meetings record that the phase 1 physical interventions were carried out as planned, without any significant divergence from the agreed programme of activities (minutes of meetings on 24 January 2014). Minor adaptations to physical interventions were responsive to local conditions and community responses; this is typical of the WIAT programme and would be expected of any such project.

The implementation of the social interventions was so compressed in timing that it was not possible for FCS staff to undertake all the activities, as would normally be the case. An experienced external ranger was therefore contracted by FCS to undertake the social interventions at intervention sites A and B (minutes of meetings on 20 May and 24 July 2014). This proved successful and received positive feedback from the project manager. However, it did mean that the interventions at site C were less numerous and not delivered by the same people as those in sites A and B (minutes of meetings on 29 January 2015).

The desirability of deterring vandalism and maintaining the quality of the site experience is always an issue in WIAT projects. During the two phases of interventions, between 2013 and early 2015, FCS ensured that any items suffering major vandalism were repaired or replaced and the sites were kept at reasonable levels of maintenance. However, once the intervention phases were completed, no further maintenance was carried out by FCS.

In summary, the interventions were not adapted in major ways, other than in the hiring of an external contractor as a ranger to undertake the social interventions at two of the sites. There was a close fit between what was planned and what was delivered under the interventions.

Other contextual factors

As part of the site selection process in 2011, contact (by e-mail or telephone) with the relevant local authority planning departments was necessary to establish that there were no plans for change in the woodland sites under consideration other than the WIAT interventions. We also enquired about any changes planned for the survey communities or the wider neighbourhood context during the course of the study that might influence the study results, but did not identify any factors that appeared likely to do so.

When preparing for community-led audits (see *Environmental audits*) and focus groups (see *Community focus groups and interviews*), we again contacted the local authority planning departments and community planning officers to assist in making contact with local community members and facilitators. We also enquired whether or not any important changes had been experienced in any of the communities, such as new building developments or urban renewal projects. In the case of intervention site B, wider community developments were identified that had taken place during the course of the study and may have had an influence on outcomes. The evidence for these comes from personal communications with local authority planners and from local newspaper reports (*The Herald*, *Paisley Daily Express*, *The Sun*) between 2012 and 2014.

In 2012, plans for major redevelopment of the town centre in which intervention site B is located, were approved. Proposals included a new supermarket, town hall, community centre and car park. In March 2013, a new multimillion-pound leisure centre opened next to the intervention site B woodland. In 2014 there was a housing redevelopment programme that required many people to move house within the intervention site B community during the study period, as well as people moving into and out of the area. The extensive town centre redevelopment programme also started in 2014. In May–June 2015 (and coinciding with the 2015 wave 3 core survey; see *Core survey of community residents*), access paths from nearby car parks to the edge of the intervention site B woodlands were upgraded by the local council. There were concerns about the possible impact of this work on the intervention and its operation,

although these paths were outside the intervention woodland under study. As the path upgrade by the council took place only as the final wave survey was being undertaken, it is unlikely to have affected community use of the woodlands in the previous year but may have disrupted or enhanced use during the few weeks prior to some respondents completing the survey.

Core survey of community residents

The health and other impacts of the physical and social interventions were explored primarily through a survey of community residents. The survey was administered in three repeat cross-sectional waves: at baseline and after each phase 1 and phase 2 intervention in the intervention and control areas. Although originally planned as a simple, repeat cross-sectional design, the survey as completed contained a nested longitudinal cohort, as explained in more detail in *Sampling strategy* and *Recruitment*.

Questionnaire design

Primary outcome measure

The primary outcome was a measure of perceived stress, assessed using the Perceived Stress Scale (PSS). The PSS is a validated measure of the degree to which situations in one's life are appraised as stressful by considering coping resources and feelings of control.[61] Previous studies of links between natural environments and stress have used the PSS and evidence indicates that it is sensitive to change over time in relation to therapeutic interventions.[62]

Secondary outcome measures

The main secondary outcome measures used were:

- Self-reported health-related quality of life (HRQoL), measured using EuroQol-5 Dimensions (EQ-5D),[63] and mental well-being, measured using the Short Warwick–Edinburgh Mental Well-being Scale (SWEMWBS).[64]
- Self-reported PA levels, measured using the International Physical Activity Questionnaire – Short Form (IPAQ-SF), which is able to capture different levels of activity and sedentary behaviour.[65]
- Self-reported visits to the specified (i.e. intervention or control) local woodland site, including frequency of visits in summer (April–September) and winter (October–March), time spent there, activities undertaken there, whether alone or with a companion or dog, and mode of access (e.g. walking, cycling, car).[66,67]
- Self-reported visits to other local (defined as within 10–15 minutes' walk from home) green spaces, including frequency of visits in summer and in winter, activities undertaken there, whether alone or with a companion or dog and mode of access.[66]
- Perceptions and experiences of the local woodlands, including how easy it is get to the woodlands from home (ease/difficulty and estimated time to get there), perceptions of the woodlands' qualities (Likert scale items on freedom from litter, quality of entrances, paths, facilities), experience when there (Likert scale items on safety, peacefulness, a place for healthy activities, for visiting with family and friends, enjoying wildlife, natural appearance), whether or not there are direct views of the woodland from home and awareness of views of the woodland when walking around in the neighbourhood and frequency of involvement in community woodland activities (e.g. led walks, community events, educational activities, conservation or woodland management work).[66,68–71]
- Emotional connection to the natural world (connectedness with nature), measured using the Inclusion of Nature in Self (INS) scale.[72]
- Perceived restorativeness of the woodland environment, using four items from the Perceived Restorativeness Scale measuring two core components of psychological restoration ('being away' and 'fascination').[62]

- Perceptions of the local neighbourhood and social capital and cohesion measured using standard questions from the English Citizenship Survey.[73]
- A range of sociodemographic variables were also collected: gender, age group, ethnicity, socioeconomic status, country of birth, working status, educational level, disability, annual income, financial strain, children in the household, type of accommodation, accommodation satisfaction, whether or not they had a garden, whether or not they owned a dog, whether or not they had access to a motor vehicle, length of time in neighbourhood, home address and postcode.

In the wave 3 survey only, the questionnaire also included questions on awareness of the interventions:

- awareness of any change in the local woodlands and, if so, ratings of the changes (five-item scale from 'very negative' to 'very positive') and whether changes were seen in person or heard/read about
- participation in any organised activity in the woodlands in past year and, if so, with whom and when.

The full questionnaire from wave 3 can be seen in *Report Supplementary Material 1*.

Sampling strategy

We were interested in community-level change resulting from the same programme of interventions in three different sites with three matched control sites, so our analysis involved comparison of the population sample from the communities that received the intervention with those that did not. We initially selected a repeat cross-sectional survey design rather than a cohort design for pragmatic reasons: a pilot study with two communities that met the WIAT site criteria undertaken in 2006–9[34] indicated that achieving a longitudinal cohort in these settings was unlikely to be successful owing to the unwillingness of participants to be recontacted and high levels of attrition over time. Recruitment and retention of a cohort of several hundred participants in each community over a multiyear study in this context appeared unfeasible. However, following the first survey wave, at baseline, the researchers revisited the decision to reject a cohort design. Considering again the potential value gained by the inclusion of a longitudinal cohort, it was decided to attempt to establish such a cohort. A longitudinal cohort of participants was therefore targeted, nested within the cross-sectional surveys.

In determining the sample size, the literature suggested that there were likely to be gender differences in the observed effects.[26] To answer the primary research question, our sample size needed to be large enough to (1) detect an effect of the WIAT programme in the intervention group compared with the control group at each post-intervention wave, and (2) allow us to detect a gender difference in that effect. Based on data from Stigsdotter *et al.*,[27] to detect a male/female difference in means of 1.2 in each group (intervention and control), with a common standard deviation (SD) of 6.2 based on a two-sided, two-sample test with a 5% level of significance and 80% power, would require a minimum of 420 males and 420 females in each arm of the study. Therefore, a total sample size of 1680, comprising 840 intervention group and 840 control group participants, was required, with an equal split of male and female participants in each group. We did not power the study for further subgroup analysis (the added cost to power for different age groups was not considered justifiable). However, we did consider other demographic and personal variables in analysis of the data, the sequential nature of the intervention and confounders, such as life events (see *Chapter 3*). We could not completely rule out a clustering effect and did not have data available to enable us to precisely calculate the design effect caused by clustering. To take account of this we allowed for a 25% increase in our sample size beyond that based on the above power calculations. Thus, we sought a total sample size at each survey wave of 2100 (1050 per intervention or control group).

The survey was administered in three repeat cross-sectional waves at the same time of year in each case: wave 1 (baseline pre-interventions, late April to June 2013), wave 2 (follow-up, minimum of 2 months post physical environment interventions at each site, May to June 2014) and wave 3 (follow-up, minimum of 2 months post woodland promotion interventions at each site, late April to July 2015).

Recruitment

Face-to-face surveys are a robust method of data collection that maximise the level of response. Other methods, such as telephone and postal surveys that rely on self-completion, have shown declining response rates in recent years, especially in disadvantaged areas.[74] Our questionnaire was designed to be administered in a 25-minute, face-to-face, computer-assisted personal interview (CAPI) completed in the respondent's own home. The questionnaire was piloted in July 2012 to assess its time burden and participant comprehension of its questions and procedure.

A survey company with experience of recruitment in communities similar to those of the study collected the data. Fieldworkers employed by the survey company were given full training on administering the questionnaire. Surveys were completed in the participant's own home with fieldworkers moving from door to door, recruiting participants and conducting the survey. A quadruple call-back approach was adopted with fieldworkers making a minimum of four attempts to contact an address before moving on to the next randomly assigned address.

Inclusion and exclusion criteria

Individuals aged ≥ 16 years living within the intervention and control communities and within 1.5 km of a woodland site were eligible for the study. Individuals were not eligible to participate if they primarily resided outside the study sites. Individuals recruited to the linked community-led audit and community focus group branches of the study (see *Environmental audits* and *Community focus groups and interviews*) were excluded from subsequent waves of survey data collection to avoid contamination of response by their experience of in-depth involvement in the research.

Participants were selected from a postcode address file [Address Point – the then definitive Ordnance Survey product that provided a precise grid reference for each address listed in the Postcode Address File (Royal Mail data set)]. Selection used a stratified random sampling approach, stratified in accordance with distance from the WIAT intervention woodlands. This address file lists all deliverable addresses in the UK and can distinguish business and domestic addresses; we focused on domestic addresses only. Each unit postcode has a grid reference and this was used to stratify the sample by distance from the local woodland. We considered stratification by distance necessary because previous research suggests that the use of woodlands for populations living nearby may decline with distance,[30] but there is also evidence that the quality of the natural environment may moderate the effect of distance,[31] so distance was necessary to consider because the WIAT intervention is aimed at improving woodland quality. We stratified the sample in accordance with five distance points from the six WIAT-eligible woodlands. These distance points were in the range of 150 m, 300 m, 500 m, 750 m and 1500 m. Letters were then sent to the selected households informing them of the research project and that participants were being sought within the communities. The letters also contained the contact details of the research team members and their office, offering participants the opportunity to receive further information about the project or to opt out (see *Report Supplementary Materials 2–4)*. Addresses of those residents who decided to opt out were then removed from the sample. A door-to-door approach and a quadruple call-back system were used to recruit participants. Recruitment was by face-to-face request to the first adult that responded to the door-to-door approach adopted.

Obtaining a longitudinal cohort

To maintain contact with the respondents from previous surveys, a thank-you letter was sent to all the addresses where wave 1 interviews took place. Unless respondents chose to opt out after receiving this letter (the letter described how to do so), the same addresses were visited in subsequent survey waves. Interviewers were instructed to confirm whether or not the person who answered the door was the same person (name, gender, age, address) who was previously recorded in wave 1. When the original respondent could not be found or recruited, recruitment of the new respondent in the household was attempted, if eligibility criteria were satisfied. If new recruits agreed to take part in the survey, a new respondent identifier code was generated. New recruits from the same household were asked to establish the relationship to the person previously interviewed (spouse/partner, child, parent, sibling, other family member or other as specified).

The size of the cohort was determined by the extent to which we were able to obtain repeat responses by this method. The cohort consisted of respondents who had participated in at least two waves of the survey. Once data were collated, checks were undertaken for age, gender and other individual characteristics to confirm that the respondents were correctly matched at each wave. The inclusion of this cohort in the initial cross-section design required changes to the initial analysis plan (see *Chapter 5*).

Response levels

To ensure that the correct sampling and interview protocols were followed, researchers attended the company's field workers' training sessions and took part in some of the visits to interview participants. This also gave insights into the challenges of recruitment in these very deprived urban areas, where, for example, there was a relatively high rate of refusal to answer the door (despite letters being sent in advance to targeted households).

Based on the random sample of addresses taken up by the survey company from the supplied postcode files, the overall response level achieved for the three surveys was 53%, lower than originally targeted. We also calculated the level of co-operation, that is, the proportion of successful interviews achieved once personal contact with a household had been made. The definition of 'personal contact' for this calculation includes effective interviews, doorstep refusals, people who wrote to opt out of the survey after receiving the introductory letter (these were comparatively few: 181 in total in wave 1) and those unable to take part owing to language issues or incapacity. The level of co-operation excludes incorrect or unusable sample addresses (empty properties, business premises, etc.), households from which there was no reply on the doorstep (despite quadruple call-back) and households (in waves 2 and 3) at which the named respondent was not available. The overall level of co-operation was 70%.

The response levels by wave and type of site (intervention/control) are shown in *Table 5*.

Assembling a longitudinal cohort represented a considerable achievement for the study given the challenges in participant recruitment. The availability of repeated measures from the same individuals provided more statistical power for the study and gave greater confidence in interpreting cause-and-effect relationships.

The sample respondents ($n = 6317$) were classified in accordance with the wave(s) of the study they participated in. This resulted in five different types of respondents across the six sites:

1. respondents who completed waves 1 and 2 (not wave 3) – 217 participants
2. respondents who completed wave 1 (not wave 2) and wave 3 – 235 participants
3. respondents who did not complete wave 1 but completed waves 2 and 3 – 420 participants
4. respondents who completed waves 1, 2 and 3 (the complete cohort) – 277 participants
5. respondents who completed only one wave, whether wave 1, 2 or 3 (cross-sectional data) – 5168 participants.

TABLE 5 Survey response and co-operation levels by wave ($n = 6317$)

	Site								
	Intervention			Control			Total sites		
Wave	*n*	Response level (%)	Co-operation level (%)	*n*	Response level (%)	Co-operation level (%)	*n*	Response level (%)	Co-operation level (%)
1	1061	52	76	956	48	70	2117	50	73
2[a]	1054	50	70	1044	54	78	2098	52	74
3[b]	1050	57	61	1052	61	67	2102	59	64

a 26% of participants were named (i.e. repeat survey) respondents from wave 1.
b 44% of participants were named (i.e. repeat survey) respondents from wave 1 or wave 2.

Data cleaning

The data collected via the core survey were cleaned using range, consistency and logic checks to confirm their quality. These checks involved identifying the correct codification of the responses, examining missing values or abnormal patterns in the data, assessing the average interview length or the performance of the interviewers, etc.

As part of this quality control, abnormal patterns in the data were noted, principally in relation to the score of the primary outcome (PSS). It was detected that an unexpectedly large number of participants appeared to have a PSS score of 0 (indicating no stress at all) at waves 2 and 3. Furthermore (but in wave 2 of the survey only), an unexpectedly high number of participants reported a PSS score of 21. Checks on interviewer identities and process revealed that five interviewers were associated with these suspect cases throughout the follow-up household surveys. A total of 857 cases with apparently unreliable PSS scores were linked to these interviewers, of which 426 corresponded to wave 2 and 431 to wave 3.

Although no other suspicious response patterns were observed in the data sets created by these interviewers, the possibility of data fabrication could not be discounted. It was decided that, to ensure the reliability of the analysis, all data collected by the interviewers whose results for PSS were questionable needed to be excluded. The 857 problematic cases were deleted from the final sample, reducing the original data set from 6317 to 5460. The number of losses from wave 2 and the number of losses from wave 3 (the two follow-up surveys) were about equal. The analyses presented in this report use this reduced sample.

Approach to analysis

Two general approaches to quantitative analysis informed the detailed statistical analysis undertaken. First, an overall effect was estimated. This was essentially an intention-to-treat (ITT) approach. It tested whether or not living in an intervention site alone was sufficient to produce primary and secondary outcomes of interest, regardless of an individual's exposure to the intervention (captured by their engagement with woodlands, green space and natural environments).

The ITT approach considered the magnitude of the interactions between living in an intervention site (or not) and the wave of the survey. This therefore captured the *differential* impact between the intervention and control groups, in relation to the effect of the WIAT programme. The models assessed the effect of the WIAT programme by comparing the differential impact after physical (phase 1) interventions (wave 2) and after both physical and social (phase 2) interventions (wave 3) with respect to the baseline (wave 1). For this, although each difference estimate (captured by the interaction terms) was statistically determined by its own *p*-values in the models, the differences between the two post-intervention phases were established on the basis of the *p*-values of a conventional Wald test.

Second, we augmented this analysis by providing a closer inspection of the intervention effect on our primary outcome (perceived stress). This was possible by examining the differential impact of the WIAT programme as a function of three main factors: (1) levels of engagement with the woods (physical and visual), (2) gender and (3) distance to the woods. This augmented approach was used to model our primary outcome and required a rather different analytical strategy to estimate the intervention effect. A three-way interaction term was added in the models, denoted by the binary variables of type of site (i.e. intervention or control) and wave of the survey plus the corresponding indicators on levels of engagement with the local woods, gender or distance to the woods. The 'main effect' within each level of these three indicators was then given by calculating a joint test of interaction terms.

The two sets of analyses involved a series of multilevel regression models. The use of a multilevel framework was required because our full sample, created by three repeated surveys sampling individuals within spatially defined communities, also included a proportion of individuals who participated at more than one wave. Therefore, the models needed to allow for repeated observations nested within individuals as well as spatial clustering. Our multilevel approach accounted for the fact that observations made on the

same individual at two different waves were likely to be correlated. For this reason, we used individuals – the lowest level in the data – as the clustering variable in all the statistical specifications.

Given the continuous and binary forms of our different outcome measures (see *Chapter 3* for details of how these were derived), the analysis involved a combination of linear and logistic regressions. All the models were adjusted for a substantial set of individual-level characteristics considered to be potential confounders for any intervention effect. The selection was made a priori and was based on existing literature describing relationships between sociodemographic variables and both access to and use of natural environments.

As 4410 out of 5460 observations had complete information (81%), imputation techniques were considered to handle missing data. Imputation was used only for data from a particular survey wave that were missing for an individual who had participated in that wave of the survey. In other words, no participant's data were imputed other than for variables in the survey wave in which they had participated.

Specifically, we followed Rubin's rules to perform multiple imputations via chained equations. This imputation technique was used owing to its greater flexibility to account for uncertainty in the missing data mechanism; we assumed that the data were 'missing at random', meaning that the 'missingness' could be determined by known variables. The use of chained equations also had the advantage of being able to include different types of variables in the process (e.g. continuous, categorical, nominal). *Appendix 2* provides further information on the approach taken.

All analyses were conducted using the cross-sectional data set (termed panel A) and repeated with the longitudinal cohort (termed panel B). Although the former enabled us to use all individuals regardless of the number of waves in which they participated, the longitudinal cohort (panel B) allowed us to track the same participants across time. Although the cohort was not necessarily a representative subsample, it provided a form of sensitivity analysis to corroborate (or otherwise) findings from the cross-sectional data. All analyses were conducted using Stata® version 14 (StataCorp LP, College Station, TX, USA).

Chapter 3 describes the derivation of variables for considering primary and secondary outcomes in the study and details the analytical methods used.

Environmental audits

Changes in the nature and quality of the woodland sites were monitored using a site-based environmental audit tool developed by members of the research team for this purpose.[66,68,75] The tool enables change over time at a site to be captured in a systematic manner. The audit tool consists of 25 items aggregated into seven domains: neighbourhood quality, access/signage, woodland/green space quality, facilities, use, maintenance/management and security/safety. Each domain contains between two and six items; for example, the domain 'neighbourhood quality' comprises the items infrastructure, appearance, litter and maintenance. For a given woodland, the tool requires auditors to score each item on a 5-point scale ranging from 1 ('poor', the lowest score) to 5 ('excellent', the highest or 'best' score). Auditors score the woodland in accordance with their 'on the day' experiences rather than previous experiences. In addition to giving scores, the tool allows participants to add textual comments about the woodland, its characteristics and quality.

The tool has been designed and tested for use by both experts (usually landscape architects) and residents of deprived urban communities. Members of the study team, trained in the use of the tool, audited all six sites using the tool; this constituted the 'expert environmental audits' record for the study. Two members of the study team were involved in each audit of any site, in which use of the tool achieved high levels of inter-rater reliability. Expert auditors were male and female and came from diverse ethnic and cultural backgrounds.

The tool's appropriateness for community use was established in the project pilot study[34] and it has been tested for sensitivity and reliability in a study of green space in deprived urban areas of England.[66,68] Recruitment of community members undertaking audits is described in detail below; they were male and female and, reflecting the demographic profile of the study communities (see *Table 2*), were all of white British ethnicity. A copy of the audit tool can be seen *Appendix 3*.

The woodlands for each study site were audited twice in each year of the study (2013–15) capturing pre- and post-intervention conditions in both the intervention and control sites. Audits by the study team and by community members were completed in both winter (February to March) and summer (June to July) each year to capture the effects of seasonality. Audits took place on a weekday, either mid-morning or early afternoon. Before the community audits took place, members of the study team walked the sites conducting a risk assessment, familiarising themselves with the woodland and noting any potential hazards. Community participants were taken for a walk in each woodland, accompanied by the two experts, and each individual in both groups completed the audit at the site.

Recruitment of community site auditors

Participants for the community-led audits were recruited initially through the baseline survey, in which respondents could indicate their willingness to be recontacted to participate in group walks or focus groups to help with the research. This produced comparatively few positive responses and so additional individuals were recruited through contact with local community groups and facilitators and through local advertising. Participants who took part in the first audit were invited to take part in all subsequent environmental audits. We sought a balanced sample in terms of gender but diversity with regard to age and life stage.

Inclusion and exclusion criteria

As with the community core survey, individuals aged ≥ 16 years living within the intervention or control communities within 1.5 km of the study woodland site were eligible to take part in the community-led audit sections of the study.

Sample

We aimed to recruit 10 diverse members of the community to each community-led environmental audit. In practice, we found that attendance varied greatly between sites and over time. It proved very difficult to recruit individuals to the audits programmed for control site A. Despite the best efforts of the study team, no members of the community could be recruited to the winter 2013 community-led environmental audit at this site, and only one community member could be recruited to the summer 2015 audit. *Table 6* shows the participant numbers for each site at each audit point.

TABLE 6 Community-led environmental audit participant numbers

	Year						
	2013		2014		2015		
Site	Winter	Summer	Winter	Summer	Winter	Summer	Total
Intervention A	9	10	10	14	13	13	69
Intervention B	3	8	4	7	9	4	35
Intervention C	7	8	7	7	10	15	54
Control A	0	4	3	4	2	1	14
Control B	11	8	6	4	2	3	34
Control C	9	9	5	8	10	9	50
Total	39	47	35	44	46	45	256

Approach to analysis

The audit data collected from both expert and community-led audits consisted of Likert scale scores from 1 to 5 for each of the 25 items considered and any additional textual comments. For each audit completed at each site, an average was calculated for each of the seven domains into which these items fall (maximum score of 5). A final score, summed over these seven domains (maximum score of 35), represents the overall perceived quality of the woodland and its immediate surroundings. The means and SDs of total scores were calculated across all community group participants and, separately, across the two expert auditors for each site at each time point. *Appendix 3* contains the detailed results of these audits.

The resulting audit scores were used to compare intervention and control sites at each audit time point and to compare any changes over time in perceptions of the woodlands at each site. This allowed an assessment of whether or not the interventions had resulted in perceptions of improved quality of the woodlands over time compared with control sites (which had no interventions). The community audit scores were also compared with the expert scores. The use of both winter and summer audits were important because each woodland site varied in appearance quite markedly between these seasons. For example, features as varied as distant views or local litter, which might be covered by abundant summer vegetation, could be more clearly seen in winter audits. Evidence of types of use were also different between summer and winter.

To better understand the perceptions leading to community audit scores, any textual comments were also reviewed under each of the seven domains of the tool. Finally, these were compared with the themes that arose from the community focus groups (see *Community focus groups and interviews*) to reveal any common themes or disparities in community perceptions.

Community focus groups and interviews

Focus groups with local residents in the three intervention communities were used to gain additional insight into the perceptions, experience and impacts of the physical and social interventions. Qualitative methods, such as focus groups, provide insight into lived experiences and personal narratives and afford opportunities for participants to provide answers in their own words; they are not tied to a fixed set of responses within a survey. Focus groups thus provided an opportunity to investigate the lived experience of the effects of the interventions from the perspective of members of the public resident in the community. They also offered the opportunity to illuminate any findings from the core survey that might otherwise be difficult to understand or explain.

A topic guide steered the focus groups (see *Report Supplementary Material 5*). Topics included familiarity with the woodlands, use and perceptions of the woodlands pre and post intervention, awareness and perceptions of the interventions, engagement with any aspect of the interventions (especially the social interventions), impacts of the interventions (including any behaviour and/or attitude change), access to the woodlands and reasons for not visiting the woodlands. Two sets of focus groups were initially planned to take place in the three intervention communities in the final 15 months of the project, 6 and 12 months after the social interventions were completed. However, because of extensions to the project timetable in relation to the period of data analysis, the focus groups were delayed. This was in order to take into account emerging findings from the core survey about which the focus groups might provide additional explanatory insights. They were undertaken 8 and 23 months after completion of the phase 2 interventions, in November 2015 and February 2017. The focus groups were audio-recorded, with participants' consent, and transcribed. Each focus group was approximately 1 hour long.

Recruitment of community members to focus groups

As with the community-led audit participants, focus group participants were initially recruited through the baseline survey, which allowed individuals to indicate if they wished to take part in focus groups or group walks. Additional participants were recruited to these sections of the study through contact with local community groups and facilitators and through local advertising (see *Report Supplementary Material 6*). We sought a balanced sample in terms of gender but diversity regarding age and life stage (*Table 7*).

When we were recruiting participants to the focus groups, a small number of individuals ($n = 4$) expressed a wish to take part in the study but were unable or unwilling to take part in any of the planned focus groups. Consequently, to facilitate their involvement, these individuals were invited to take part in a one-to-one telephone interview with a member of the study team. The topic guide, as employed within the focus groups, guided the interviews. The interviews were audio-recorded, with participants' consent, and transcribed. Each interview took approximately 30 minutes.

Inclusion and exclusion criteria

As with the community core survey, individuals aged ≥ 16 years living within the intervention communities within 1.5 km of the study woodland site were eligible to take part in the community focus groups for the study.

Sample

We aimed to recruit six members of the community to each focus group, giving a sample of 18 participants across each set of focus groups. Ultimately, 11 individuals took part in the first set of three focus groups (one per site), with a further individual engaged through a telephone interview. The second set of three focus groups (one per site) featured 19 participants with a further three individuals participating in telephone interviews (see *Table 7*).

Approach to analysis

A hybrid approach was used to analyse the focus groups and interview transcripts. This sought to identify themes that emerged from the participants in addition to those imposed by the structure of the topic guide shown in *Report Supplementary Material 5*. Thus, we structured coding of the transcripts using both predetermined and an inductive thematic analysis.[76] Multiple siftings of the data were used to clarify and refine the themes. All transcripts were double coded and any variations in coding agreed and reconciled prior to producing the final thematic framework (see *Figure 20*).

Analysis paid particular attention to discordant voices or differing opinions and indications of unanticipated outcomes from the interventions. Interpretation of the themes was also informed by the outcomes of the community audits (see *Environmental audits*) to triangulate findings when possible.

TABLE 7 Focus group and interview participants sample

	Intervention site							
	November 2015				February 2017			
Participants	A	B	C	Total	A	B	C	Total
Gender								
Male	0	2	1 (+ 1)[a]	4	2	3 (+ 1)[a]	3 (+ 2)[a]	11
Female	4	1	4	9	2	4	5	11
Total	4	3	5 (+ 1)[a]	13	4	7 (+ 1)[a]	8 (+ 2)[a]	22

a Numbers of individual interviewees shown in brackets.

Economic evaluation

Costs of interventions

In addition to health outcomes data collected via the core community survey, the economic evaluation drew on resource data collected directly from FCS. This analysis costed the time commitment of members of the FCS team involved in supporting the physical intervention, including the time spent administering the contracting process and monitoring compliance with the successful contractor. It also included time spent administering and delivering the programme of social interventions. An assessment of the costs of the WIAT programme was developed by using a top-down approach.[77,78] Units costs were determined by the FCS internal and external costing model: internal unit costs in the form of pay rates per day for various grades were applied to various activities related to the delivery of the interventions. To carry out the physical intervention, the work was contracted to third parties and, therefore, the cost equated to the contract value plus the additional monitoring/administration time of FCS using internal pay rates per day for a given grade. Staff involved in the WIAT programme at FCS regularly completed a costing model in Microsoft Excel® version 16 (Microsoft Corporation, Redmond, WA, USA) to estimate this time commitment for the length of the study. The model recorded percentage time commitment in days on a monthly basis for different grades of staff. This time commitment was costed at an agreed unit rate that covered staff salaries and overheads and FCS support for both the physical and social interventions. The costs (see *Table 27* for detailed costs relating to 2013/14) represent the fully costed input for the delivery of the interventions.

Assessment of health-related quality of life

The primary focus of the economic evaluation was the core survey response on the five-item EQ-5D scale that captures a description of five dimensions of health state. This allows the derivation of utilities to calculate quality-adjusted life-years (QALYs).

The EQ-5D data collection used both the old three-level version (EQ-5D-3L) and the new five-level version (EQ-5D-5L) of the EQ-5D questionnaire. The EQ-5D-3L was used in wave 1 and the EQ-5D-5L was used in waves 2 and 3. In both versions the health states are reported as an index on the questionnaire responses, with 11111 for full health for both versions and 33333 and 55555 for worst health for the EQ-5D-3L and EQ-5D-5L respectively. For the EQ-5D-3L, this index was used to derive utilities from the predetermined values sets obtained from the UK general public.[79] At the time of analysis, there were no utility value sets for the EQ-5D-5L for the wider UK population, only for England.[80] Furthermore, the EQ-5D-5L is not recommended for use by the National Institute for Health and Care Excellence (NICE) until the impact of its adoption is fully explored, as it has been found that improvements in HRQoL are valued less with the EQ-5D-5L than the EQ-5D-3L, with implications for economic evaluation.[81]

When both the EQ-5D-3L and EQ-5D-5L have been used, NICE guidelines recommend the mapping approach, also known as a crosswalk approach, to ensure consistency of HRQoL utilities.[82] We used the crosswalk approach to calculate HRQoL utilities from responses from the EQ-5D-5L index profiles in waves 2 and 3 that were consistent with the HRQoL utilities responses from the EQ-5D-3L index profiles in wave 1. This approach is based on the distribution similarities of the two versions of the EQ-5D questionnaires.[83] The EQ-5D-5L health states provide 3125 indices that are distributed on a scale of –0.594 to 1 (index profile 55555 = –0.594 and 11111 = 1)[83] and the EQ-5D-3L version provides 243 indices that are distributed on the same scale of –0.594 to 1 (index profile 33333 = –0.594 and 11111 = 1).[79] These distribution similarities provide comparability of the two versions of the EQ-5D. A Microsoft Excel tool known as the 'EQ-5D-5L Crosswalk Index Value Calculator' developed by the EuroQol group was used to calculate the crosswalk index values for the EQ-5D-5L dimension scores.

Cost–consequences analysis

Cost–consequences analysis (CCA) was used to present the total cost of the intervention and the primary and secondary outcomes of the WIAT interventions in a balance sheet format.[84] This approach presents policy- or decision-makers with a comprehensively wide range of outcomes to judge the impact of the

intervention, including both health effects and non-health effects. However, it stops short of a full evaluation as it does not present the values placed on the outcomes that are affected by the intervention.

Cost–utility analysis

A cost–utility analysis (CUA) is the most common form of evaluative method used in health economic evaluation. It compares the total costs of the intervention with estimated QALYs gained from the intervention based on the estimated impact on HRQoL utilities of the sort provided by the EQ-5D descriptive system responses. In an exploratory analysis, a CUA was conducted from the EQ-5D responses for the WIAT intervention over the time scale of the study.

Sensitivity analysis

Uncertainty surrounding the costs and EQ-5D HRQoL utilities was quantified through a probabilistic sensitivity analysis (PSA).[85,86] This was undertaken using 5000 Monte Carlo simulations that repeatedly created random data through bootstrapping. A gamma probability distribution was assigned to the cost parameter, computed from the variation of individual costs in the costing model.[87,88] The EQ-5D HRQoL results from the adjusted ITT models were assigned a normal distribution with point estimates and standard errors (SEs) taken directly from the regression results. The PSA allowed the estimation of 95% confidence intervals (CIs) from the bootstrapped replicates of data using the percentile approach with a lower and upper percentile of 0.025 and 0.975 respectively.[88]

All the bootstrapping was performed in Microsoft Excel and implemented using a Microsoft Excel macro. The results of all simulations were combined to give overall incremental cost-effectiveness ratio (ICER) results. The bootstrapped pairs of incremental cost and incremental QALYs are presented using the cost-effectiveness plane. The cost-effectiveness plane depicts the point in the quadrant where each bootstrapped pair of the incremental cost and incremental QALY is positioned. The vertical and horizontal axes represent incremental costs and incremental QALYs respectively.

Ethics

The study was granted ethics approval by the University of Edinburgh, Edinburgh College of Art Research, Ethics and Knowledge Exchange Committee (reference number 19/06/2012).

An introductory letter with participant information was sent to all potential core survey households, explaining that a surveyor would be calling and requesting an interview with a household member (see *Report Supplementary Materials 2–4*). The letter gave contact details for the project co-ordinator and allowed recipients the opportunity to ask questions and/or opt out of being contacted further. Only households that made no opt-out request were subsequently contacted by interviewers, who again introduced the project, and the purpose and treatment of any personal data obtained, before proceeding with the interview. Informed consent was thus obtained orally for those responding to the core survey questionnaire; these participants were assured that all information would be treated as entirely confidential and that it would not be possible to identify any individuals in any published use of the research (see the scripted version of the questionnaire in *Report Supplementary Material 1*).

All participants in community-led environmental audits, focus groups or interviews were invited to give informed consent to participate. Again, they were assured that all information would be treated as entirely confidential and that it would not be possible to identify any individuals in any published use of the research. *Report Supplementary Materials 7–10* contain all the advisory letters and consent forms used for data collection via the community audits and the focus groups and interviews.

All original data were held securely at the University of Edinburgh's OPENspace Research Centre. Any personal data, including respondents' contact details (names, addresses, telephone numbers and e-mail addresses), were held in password-protected electronic files in secure data storage, with only the principal

investigator, the researcher managing the data and project manager (if different) having access. For the purpose of data analysis, participants' data were anonymised and encrypted to be able to share them securely within the wider research team. Access was restricted to team members only. In accordance with the University of Edinburgh's protocols relating to data storage and data handling, data protection agreements were signed between the different institutions involved in the project.

Public and stakeholder involvement

Members of the public and diverse stakeholders were actively involved in the research throughout the course of the study and particularly in the environmental audits to assess the quality of the woodland environment and in focus group work.

When first planning the study, members of the study team worked closely with FCS, being the organisation responsible for delivering the intervention, to develop an appropriate research design. The study team continued to work in partnership with FCS throughout the course of the research. FCS staff were key in helping the study team to identify appropriate intervention and control sites; they provided information on the planning and progress of the physical and social interventions, the time they spent working on these interventions and levels of participation in the social interventions. Regular progress meetings were held with members of FCS staff throughout the study, as described in *The Woods In and Around Towns interventions: environmental and social interventions*.

A study steering committee (SSC), chaired by an independent adviser on environment and human health, with representatives from forestry (ex Forestry Commission), public health and the Scottish Government's Rural and Environment Science and Analytical Services, plus two expert academic advisors (from Uppsala University and Forest Research), guided the study on behalf of the National Institute for Health Research (NIHR). SSC meetings were held throughout the course of the project to give advice to the study team and consider, in particular, issues such as adherence to the study protocol, progress against milestones, the implications of findings and effective dissemination.

Members of the public were actively engaged in the research through participation in the core community survey, community-led environmental audits of all sites and community focus groups and interviews. Through these different vehicles, members of the public were involved in the research in 2013, 2014, 2015 and 2017. Their involvement was critical to the research, providing the data on which our findings, discussion and conclusions are based.

Chapter 3 Results from the core survey

Characteristics of participants in the sample

Baseline characteristics of participants

Tables 8 and *9* draw on imputed data to give baseline descriptive characteristics of participants for the cross-sectional data set (panel A) and cohort sample (panel B) respectively. Because all the covariates take a categorical form, we report proportions, stratified by study arm. To inspect the extent of imbalance in the covariates at baseline, a *p*-value for test of differences is also reported.

TABLE 8 Baseline characteristics of participants: panel A – cross-sectional sample (imputed data)

Variable	Site (%)		Total (%) ($N = 2117$)	*p*-value for test of difference[a]
	Intervention ($n = 1061$)	Control ($n = 1056$)		
Age (years)				
16–24	9.1	7.9	9.0	0.33
25–34	18.4	14.5	16.4	**0.02**
35–44	16.0	14.3	15.2	0.27
45–54	19.4	20.1	19.7	0.67
55–64	12.1	16.7	14.4	**0.002**
65–74	18.5	20.2	19.3	0.32
≥ 75	6.5	6.2	6.4	0.78
Gender				
Female	61.3	62.2	61.8	0.68
Male	38.6	37.8	38.2	0.68
Life events				
Better than normal	7.3	7.8	7.5	0.66
Much worse than normal	9.5	12.6	11.1	**0.02**
No different than normal	25.0	23.3	24.1	0.37
Nothing has happened in last 12 months	58.2	56.3	57.3	0.38
Social class[b]				
I	2.5	4.1	3.3	**0.04**
II	18.7	21.9	19.2	**0.002**
III	18.7	19.6	19.1	0.59
IV	25.0	22.3	23.7	0.16
V	37.3	32.1	34.7	**0.01**

continued

TABLE 8 Baseline characteristics of participants: panel A – cross-sectional sample (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 2117$)	*p*-value for test of difference[a]
	Intervention ($n = 1061$)	Control ($n = 1056$)		
Highest level of qualification[c]				
No qualification	41.4	32.8	37.1	**< 0.001**
1	30.6	38.0	34.3	**< 0.001**
2	17.4	12.5	14.9	**0.002**
3	7.0	9.2	8.1	0.06
4	3.7	7.5	5.6	**< 0.001**
Working status				
No	56.1	58.5	57.3	0.26
Yes	43.4	41.5	42.7	0.26
Income coping				
Finding it difficult on present income	25.0	17.8	21.4	**< 0.001**
Coping on present income	53.2	54.4	53.8	0.58
Living comfortably on present income	21.9	27.8	24.9	**0.002**
Distance to woods (m)				
≤ 150	6.5	26.2	16.3	**< 0.001**
151–300	12.0	26.4	19.2	**< 0.001**
301–500	15.7	24.7	20.2	**< 0.001**
501–750	31.0	15.2	23.1	**< 0.001**
751–1500	34.8	7.4	21.1	**< 0.001**
Access to a car				
No	44.9	32.8	38.8	**< 0.001**
Yes	55.1	67.2	61.2	**< 0.001**
Smoking status				
Currently smoke	40.8	28.2	34.5	**< 0.001**
Smoked in the past	21.1	18.0	19.6	0.08
Never smoked	38.1	53.8	45.9	**< 0.001**
Disability				
No	86.6	88.6	87.6	0.16
Yes	13.4	11.4	12.4	0.16
Health limited				
Yes, limited a lot	8.8	11.3	10.0	0.06
Yes, limited a little	19.7	16.7	18.2	0.07
No, not limited at all	71.5	72.1	71.8	0.79
Dog ownership				
No	77.5	73.0	75.2	**0.02**
Yes	22.5	27.0	24.8	**0.02**

TABLE 8 Baseline characteristics of participants: panel A – cross-sectional sample (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 2117$)	p-value for test of difference[a]
	Intervention ($n = 1061$)	Control ($n = 1056$)		
Children in household				
No	70.8	70.9	70.9	0.96
Yes	29.1	29.0	29.1	0.96
Site pair				
A	33.7	33.1	33.4	0.77
B	33.2	33.1	33.2	0.98
C	33.1	33.7	33.4	0.76

a p-values of < 0.05 indicated in bold.
b Based on occupational categories: I = highest grade occupations; V = state pensioners, unemployed or lowest grade occupations.
c Levels range from 1 (school leaver qualifications: O grade, standard grade or equivalent) to 4 (higher education qualifications: first degree or higher).

TABLE 9 Baseline characteristics of participants: panel B – cohort sample (imputed data)

Variable	Site (%)		Total (%) ($N = 609$)	p-value for test of difference[a]
	Intervention ($n = 280$)	Control ($n = 329$)		
Age (years)				
16–24	7.1	3.6	5.3	0.06
25–34	10.0	13.1	11.7	0.24
35–44	12.1	13.1	12.6	0.73
45–54	19.6	17.6	18.6	0.53
55–64	14.3	17.9	16.3	0.22
65–74	16.8	17.0	16.9	0.94
≥ 75	20.0	17.6	18.7	0.46
Gender				
Female	61.1	9.1	63.2	0.31
Male	38.9	35.0	36.8	0.31
Life events				
Better than normal	4.3	9.1	6.9	**0.02**
Much worse than normal	14.6	17.0	15.9	0.42
No different than normal	25.3	24.6	25.0	0.83
Nothing has happened in last 12 months	55.7	49.2	52.2	0.11
Social class[b]				
I	3.9	4.3	4.1	0.82
II	11.1	22.8	17.2	**< 0.001**
III	18.4	15.9	17.0	0.42
IV	23.6	24.7	24.2	0.75
V	430	32.4	37.3	**0.007**

continued

TABLE 9 Baseline characteristics of participants: panel B – cohort sample (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 609$)	*p*-value for test of difference[a]
	Intervention ($n = 280$)	Control ($n = 329$)		
Highest level of qualification[c]				
No qualification	57.0	41.3	48.5	**< 0.001**
1	23.7	33.1	28.8	**0.01**
2	11.4	9.1	10.2	0.35
3	5.0	7.6	6.4	0.18
4	2.9	8.8	6.0	**0.001**
Working status				
No	69.6	65.2	67.2	0.24
Yes	30.4	34.8	32.8	0.24
Income coping				
Finding it difficult on present income	26.0	16.5	20.9	**0.005**
Coping on present income	52.1	57.3	54.9	0.20
Living comfortably on present income	21.9	26.2	24.2	0.22
Distance to woods (m)				
≤ 150	5.4	24.6	15.8	**< 0.001**
151–300	12.9	22.8	18.2	**0.001**
301–500	15.7	24.6	20.5	**0.006**
501–750	44.3	18.5	30.4	**< 0.001**
751–1500	21.8	9.4	15.1	**< 0.001**
Access to a car				
No	47.5	34.0	40.2	**< 0.001**
Yes	52.5	66.0	59.8	**< 0.001**
Smoking status				
Currently smoke	36.9	26.4	31.3	**0.006**
Smoked in the past	24.7	20.4	22.3	0.20
Never smoked	38.4	53.2	46.2	**< 0.001**
Disability				
No	81.9	87.5	84.9	0.05
Yes	18.1	12.5	15.1	0.05
Health limited				
Yes, limited a lot	13.9	13.4	13.6	0.84
Yes, limited a little	27.5	21.0	24.0	0.06
No, not limited at all	58.6	65.7	62.4	0.07
Dog ownership				
No	76.8	74.5	75.5	0.51
Yes	23.2	25.5	24.5	0.51
Children in household				
No	76.1	75.1	75.5	0.78
Yes	23.9	24.9	24.5	0.78

TABLE 9 Baseline characteristics of participants: panel B – cohort sample (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 609$)	p-value for test of difference[a]
	Intervention ($n = 280$)	Control ($n = 329$)		
Site pair				
A	32.1	14.6	22.7	**< 0.001**
B	53.9	36.5	44.5	**< 0.001**
C	13.9	48.9	32.8	**< 0.001**

a p-values of < 0.05 indicated in bold.
b Based on occupational categories: I = highest grade occupations; V = state pensioners, unemployed or lowest grade occupations.
c Levels range from 1 (school leaver qualifications: O grade, standard grade or equivalent) to 4 (higher education qualifications: first degree or higher).

At baseline, panel A comprises a total of 2117 participants (see *Table 8*). Of these participants, 609 correspond to the cohort sample (see *Table 9*), panel B, nested within the cross-sectional data set.

In the following commentary we note only significant differences based on $p < 0.05$.

At baseline, panel A (see *Table 8*) had differences between intervention and control samples in two of the age groups and more 'much worse than normal' life events in the control group. There were more lower social class participants in the intervention group and more higher social class participants in the control group. The difference is more significant with regard to the educational levels of the two groups, with the intervention group having more participants with no qualifications and the control having more with higher and further educational levels. This difference is also reflected in the larger numbers finding it difficult to cope on their income in the intervention group and more in the control group living comfortably on their income. Despite attempts to match sites in accordance with physical characteristics, including woodlands, the intervention group had fewer people living close to their local woodlands and more living at a distance of ≥ 751 m than the control group. The intervention group also had lower numbers of participants with access to a car. In health terms, there were more smokers in the intervention group. The control group had more dog owners than the intervention group. There were no other significant differences between the two groups in the sample.

There were some differences in profile between panel A and panel B. As with panel A at baseline, in the panel B sample (see *Table 9*) many individual characteristics were not significantly different between the intervention and control groups but there were a number of significant differences. Unlike panel A, there were no differences in the age profile between intervention and control groups and the control group life events ratings included more 'better than normal'. The pattern of significant differences for social class, educational qualifications, income coping, proximity to the local woodlands, access to a car and smoking status matched that of panel A, with the intervention group showing a disadvantaged profile in these characteristics compared with the control group. Unlike in panel A, there are also significant differences in the proportions of the panel B sample from intervention or control sites in each of the site pairs.

Follow-up characteristics of participants in the wave 2 and 3 sample

The characteristics of participants in the two follow-up waves of data, both for the cross-sectional data set and for the cohort sample, differ from baseline in some important ways (see *Appendix 4* for details).

There was a relative reduction in the sample size owing to the exclusion of problematic cases from the final data set as described earlier. The repeat cross-sectional data set used for analysis from waves 2 and 3 had 1672 and 1671 cases respectively. Likewise, the number of cohort participants was 350 at wave 2 and 402 at wave 3.

Panel A at wave 2 showed no significant differences between intervention and control in terms of age, whereas there were differences in two of the age groups in wave 3. Life events patterns were more varied across the two groups (more in the control group were 'better than normal' in both waves 2 and 3). There were a number of differences in social class (wave 2 only) and in educational qualification (waves 2 and 3), matching those found in wave 1, in which the intervention group mostly showed lower social class and educational qualifications than the control group. Unlike in wave 1, there were more not in work in the intervention group in waves 2 and 3. As in wave 1, more in the intervention group were finding it hard to cope on their income and more in the control group were living comfortably on their income (waves 2 and 3). As with wave 1, the intervention group had fewer people living close to woodlands and more living further away than the control group. As in wave 1, the intervention group in waves 2 and 3 had comparatively lower levels of access to a car, higher numbers smoking and lower dog ownership. In wave 3 only, there were more in the intervention group whose health was limited a little and more in the control group with no health limitations. There was a notable difference in sample size between the site pairs: there were significantly fewer participants in intervention site A (in both waves 2 and 3) and in control site B (wave 2 only).

In the panel B sample for waves 2 and 3 there was only one significant difference in one age group (more participants aged 55–64 years in the wave 2 control sample) between intervention and control samples. As with wave 1, wave 2 control participants had more life events in the 'better than normal' category than the intervention group. Social class and educational qualifications patterns in waves 2 and 3 largely matched those of wave 1, as might be expected, with differences between intervention and control groups more significant in wave 3 than in wave 2. As with wave 1, there were significantly more in the intervention group finding it difficult to cope on their income in waves 2 and 3, with the control group having significantly more living comfortably on their income by wave 3. Patterns of proximity to local woodlands and access to a car matched those of wave 1 in waves 2 and 3, with differences between intervention and control being more significant by wave 3. Differences in smoking were not significant in wave 2 but were significant in wave 3, with the control group having fewer smokers, as in wave 1, and the intervention group having significantly more who smoked in the past in wave 3, compared with significantly more currently smoking in wave 1. The only other significant differences were between site pairs, with a comparatively larger sample size in intervention site B and in control site C in waves 2 and 3 (as in wave 1), whereas the comparatively larger sample size in intervention site A (significant in waves 1 and 2) was no longer significant by wave 3.

Preparing outcome variables for analysis

In this subsection, we describe the derivation of the primary outcome and the construction of the secondary outcomes that were considered in the study. The analyses and associated imputations used either continuous variables or binary variables as outcome measures. Tables are included in this section to illustrate the pattern of responses to questions that have multiple categories prior to their reduction to binary outcomes for analysis. The full set of responses based on imputed data for secondary outcome variables is shown in *Appendix 5*.

Primary outcome variable: Perceived Stress Scale

The primary outcome of the study was perceived stress, measured through the 10-item PSS. We followed standard rules to derive our PSS score. The raw measure included four positively stated items and six negatively stated items. The items were based on Likert scale responses of 'never', 'almost never', 'sometimes', 'fairly often' and 'very often'. The final score was then calculated by reversing responses to the four positively stated items and then summing across all 10 scale items. The resulting variable was treated as a continuous variable ranging from 0 to 40, with lower values denoting better mental health outcomes.

Secondary outcome variables

The study considered a set of secondary outcomes, summarised in *Table 10* (see *Report Supplementary Material 1* for the full questionnaire and *Appendix 5* for full reporting of all secondary outcome data). These secondary outcomes are related to the different pathways hypothesised to underpin the relationship

TABLE 10 Secondary outcomes: distal and proximal

Outcome	Subset
Distal	
Health-related	Physical activity
	Connectedness to nature
	Social cohesion
Proximal	
Behaviour	Nature visits
	Length and frequency of visits to the woods
	Viewing the woods
Engagement with woods and their use	Activities undertaken in the woods
	Awareness of the woods
Enhanced environment	Experience of natural environments
	Awareness of the woods

between natural environments and mental health, particularly perceived stress, as shown in our logic model (see *Figure 1*).

The derivation of secondary outcomes proceeded as described in the following sections.

Health-related outcomes

Physical activity

Physical activity was measured using the International Physical Activity Questionnaire (IPAQ), specifically the IPAQ-SF. The IPAQ collects information regarding the duration (in minutes) and frequency (in days) for three generic activities: walking, moderate intensity and vigorous intensity.

We followed standard IPAQ data-cleaning procedures[89] to compute measures of PA as follows:

- Any duration of activities of < 10 minutes was recoded to 0.
- To truncate measures, any duration of activities > 240 minutes was recoded to 240 minutes.
- Participants reporting a PA of > 16 hours were excluded from the analysis.
- To obtain the weekly minutes of walking, moderate and vigorous activities in terms of the metabolic equivalent (MET), participants' estimates of the average number of minutes of activity were calculated by multiplying the weekly frequency by the corresponding METs.
- To obtain a total PA score, the three generic activities were summed.

The above procedure produced a total of four continuous measures of PA, expressed in terms of MET-minutes per week:

1. walking
2. moderate
3. vigorous
4. overall PA.

Connectedness to nature

The INS scale measures participants' sense of connectedness to nature from 1 to 7 using a visual scale. Participants identified the picture that best represented their connection, where 1 denoted no connection at all and 7 denoted a full connection. We used this scale as a continuous variable to investigate the extent to which participants felt emotionally connected to natural environments.

Social cohesion

Social cohesion was measured using three items reflecting the participants' opinions of their community's collective strength:

1. Neighbourhood cohesion – to what extent do you agree or disagree that people in this neighbourhood pull together to improve the neighbourhood?
2. Neighbourhood trust – how many people in your neighbourhood can be trusted?
3. Neighbourhood belonging – how strongly do you feel you belong to your immediate neighbourhood?

Although the phrasing of the categories of each of the above items differed, the three items used a similar 4-point scale, thus allowing us to create a reliable scale (Cronbach's alpha = 0.70). We summed across the three items to obtain a social cohesion score. This produced a variable ranging from 3 to 12, which we treated as continuous, higher scores representing better community collective strength.

Behaviour outcomes

Nature visits

To measure changes in engagement with the natural environment, we combined information from the following questions:

- Have you visited the local woodlands (subject of the study) in the last year?
- Have you visited other local parks or green spaces in the last 12 months?

Both questions could be answered by either 'yes' or 'no' at each survey wave. The first question provided information on whether or not individuals visited the woods that were the subject of the study, and through the second question we gathered information on whether or not individuals visited green spaces other than the controlled sites. We set a value of 1 if participants responded 'yes' and 0 otherwise. The resulting variable took a binary form.

Length and frequency of visits to the woods

Length of visits was measured using the survey question shown in *Table 11*. Those 'not asked' represent those not visiting their local woods in the past year. The number not visiting had declined slightly (but not significantly) by wave 3.

Based on NHS-recommended levels of PA for adults (a minimum of 30 minutes of moderate to vigorous activity on at least 5 days per week)[90] and the distribution of categories within this question, participants' responses were dichotomised, setting a value of 1 for participants whose length of time in the woods was any category indicating > 30 minutes and 0 for participants who responded either '≤ 15 minutes' or '15–30 minutes'. Because the question in *Table 11* was addressed only to participants who visited the woods that were the subject of study, those not asked were not included in the construction of the binary outcome.

Frequency of visits was also measured. Participants who visited the woods were also asked, at each survey wave, how frequently they did so during the winter and summer seasons (*Table 12*). Again, those 'not asked' represent those not visiting their local woods in the past year.

TABLE 11 Length of visits to the woods

Item responded to	Participants, *n* (%)			
	Wave 1	Wave 2	Wave 3	Total
On average, during the last 12 months, how long did you normally spend at the local woods (subject of study)?				
Intervention				
Not asked	830 (78.23)	592 (80.00)	614 (75.34)	2036 (77.83)
≤ 15 minutes	18 (1.70)	20 (2.70)	8 (0.98)	46 (1.76)
15–30 minutes	45 (4.24)	29 (3.92)	29 (3.56)	103 (3.94)
30 minutes to 1 hour	108 (10.18)	57 (7.70)	101 (12.39)	266 (10.17)
1–2 hours	52 (4.90)	33 (4.46)	52 (6.38)	137 (5.24)
2–5 hours	8 (0.75)	9 (1.22)	11 (1.35)	28 (1.07)
> 5 hours	0	0	0	0
Total	1061 (100)	740 (100)	815 (100)	2616 (100)
Control				
Not asked	721 (68.28)	659 (70.78)	651 (76.14)	2031 (71.46)
≤ 15 minutes	41 (3.88)	29 (3.11)	9 (1.05)	79 (2.78)
15–30 minutes	93 (8.81)	57 (6.12)	45 (5.26)	195 (6.86)
30 minutes to 1 hour	158 (14.96)	120 (12.89)	84 (9.82)	362 (12.74)
1–2 hours	37 (3.50)	48 (5.16)	55 (6.43)	140 (4.93)
2–5 hours	6 (0.57)	16 (1.72)	10 (1.17)	32 (1.13)
> 5 hours	0	2 (0.21)	1 (0.12)	3 (0.11)
Total	1056 (100)	931 (100)	855 (100)	2842 (100)

TABLE 12 Frequency of visits to the woods in summer and winter seasons

Item responded to	Participants, *n* (%)			
	Wave 1	Wave 2	Wave 3	Total
How frequently did you visit these local woodlands last summer (i.e. between April and September)?				
Intervention				
Not asked	830 (78.23)	592 (80.11)	614 (75.25)	2036 (77.83)
Every day	41 (3.86)	15 (2.03)	30 (3.68)	86 (3.29)
Several times a week	76 (7.16)	45 (6.09)	69 (8.46)	190 (7.26)
Once a week	27 (2.54)	17 (2.30)	41 (5.02)	85 (3.25)
Several times a month	37 (3.49)	27 (3.65)	19 (2.33)	83 (3.17)
About once a month	19 (1.79)	16 (2.17)	17 (2.08)	52 (1.99)
Less often	24 (2.26)	24 (3.25)	16 (1.96)	64 (2.45)
Not at all	7 (0.66)	3 (0.41)	10 (1.23)	20 (0.76)
Total	1061 (100)	739 (100)	816 (100)	2616 (100)

continued

TABLE 12 Frequency of visits to the woods in summer and winter seasons (*continued*)

Item responded to	Participants, *n* (%)			
	Wave 1	Wave 2	Wave 3	Total
Control				
Not asked	721 (68.28)	659 (70.78)	651 (76.14)	2031 (71.46)
Every day	28 (2.65)	32 (3.44)	34 (3.98)	94 (3.31)
Several times a week	97 (9.19)	68 (7.30)	66 (7.72)	231 (8.13)
Once a week	54 (5.11)	43 (4.62)	33 (3.86)	130 (4.57)
Several times a month	64 (6.06)	76 (8.16)	41 (4.80)	181 (6.37)
About once a month	34 (3.22)	23 (2.47)	15 (1.75)	72 (2.53)
Less often	51 (4.83)	27 (2.90)	12 (1.40)	90 (3.17)
Not at all	7 (0.66)	3 (0.32)	3 (0.35)	13 (0.46)
Total	1056 (100)	931 (100)	855 (100)	2842 (100)
How frequently did you visit these local woodlands last winter (i.e. between October and March)? *Intervention*				
Not asked	830 (78.23)	592 (80.00)	614 (75.25)	2036 (77.80)
Every day	34 (3.20)	10 (1.35)	22 (2.70)	66 (2.52)
Several times a week	38 (3.58)	26 (3.51)	28 (3.43)	92 (3.52)
Once a week	14 (1.32)	16 (2.16)	19 (2.33)	49 (1.87)
Several times a month	31 (2.92)	15 (2.03)	14 (1.72)	60 (2.29)
About once a month	21 (1.98)	17 (2.30)	20 (2.45)	58 (2.22)
Less often	62 (5.84)	40 (5.41)	69 (8.46)	171 (6.53)
Not at all	31 (2.92)	24 (3.24)	30 (3.68)	85 (3.25)
Total	1061 (100)	740 (100)	816 (100)	2617 (100)
Control				
Not asked	721 (68.28)	659 (70.78)	651 (76.14)	2031 (71.46)
Every day	23 (2.18)	25 (2.69)	23 (2.69)	71 (2.50)
Several times a week	66 (6.25)	46 (4.94)	47 (5.50)	159 (5.59)
Once a week	39 (3.69)	28 (3.01)	20 (2.34)	87 (3.06)
Several times a month	43 (4.07)	68 (7.30)	28 (3.27)	139 (4.89)
About once a month	30 (2.84)	32 (3.44)	17 (1.99)	79 (2.78)
Less often	90 (8.52)	39 (4.19)	35 (4.09)	164 (5.77)
Not at all	44 (4.17)	34 (3.65)	34 (3.98)	112 (3.94)
Total	1056 (100)	931 (100)	855 (100)	2842 (100)

Based on the distribution of the sample for different categories in these questions, we created two dichotomised variables measuring the frequency of visits during these seasons, giving a value of 1 if participants responded 'every day', 'several times a week' or 'once a week' and a value of 0 if their response was 'several times a month', 'about once a month', 'less often' or 'not at all'. Again, the 'not asked' category was not included in the construction of the binary outcome.

Viewing the woods

The WIAT interventions were unlikely to alter whether or not people could view the local woods from their home; however, enhanced awareness of the woods and their potential attractiveness might alter people's patterns of behaviour, including their enjoyment of viewing the woods when going about their neighbourhood. For this reason, visual contact with the woods was measured via the following survey question:

- When you are walking about your neighbourhood, are you aware of any views to woodlands or green spaces?

At each survey wave, participants were able to answer the above question with 'yes', 'yes, a partial view' or 'no'. Based on the distribution, we dichotomised participants' responses, giving a value of 1 for those who responded 'yes' or 'yes, a partial view' and 0 otherwise.

Engagement with woods and their use

The social (phase 2) WIAT interventions were aimed at encouraging the local community to participate in a range of activities in the woods and to find out more about the woods.

Activities undertaken in the woods

For those who did report visiting the woods, respondents were asked to indicate the activities undertaken (they could choose as many items as were relevant). Of the eight options offered (including an option to specify something 'other' than what was listed), only four were identified in sufficient numbers to offer a meaningful basis for analysis. They were:

1. go for a walk
2. walk a dog
3. go out with my family
4. relax.

We created binary outcomes for each of these four activities, giving a value of 1 if participants pursued the activity while visiting the woods and 0 if they did not.

Awareness of the woods

Awareness of local woods and opportunities to engage with them may result in both positive and negative perceptions of their quality. By contrast, a lack of awareness of the local woods is reflected in people not knowing the quality of their woods.[34] We measured the degree of participants' awareness of the woodlands' quality via the survey question in *Table 13*. As this table shows, participants were able to rank the quality of the woods only if they were aware of the woodlands' locations, otherwise their response was 'Do not know what my local woodlands are'. A binary outcome variable measuring the degree of awareness of the woods was then created by setting a value of 1 if participants rated, at any level, the quality of the woods and 0 if they did not know where their local woodlands were.

Enhanced environment

Experience of the natural environment

In addition to awareness of the local woods, and to measure changes in terms of participants' experience of the woods, the following perceived restorativeness items were included in the survey questionnaire.

TABLE 13 Awareness of the woods

Item responded to	Participants, *n* (%)			
	Wave 1	Wave 2	Wave 3	Total
Overall, what do you think about the quality of these local woodlands?				
Intervention				
Do not know what my local woodlands are	476 (44.86)	339 (45.81)	257 (31.5)	1072 (40.96)
Very good	53 (5.00)	44 (5.95)	63 (7.72)	160 (6.11)
Good	219 (20.64)	202 (27.30)	358 (43.87)	779 (29.77)
Neutral	171 (16.12)	114 (15.41)	94 (11.52)	379 (14.48)
Poor	116 (10.93)	32 (4.32)	36 (4.41)	184 (7.03)
Very poor	26 (2.45)	9 (1.22)	8 (0.98)	43 (1.64)
Total	1061 (100)	740 (100)	816 (100)	2617 (100)
Control				
Do not know what my local woodlands are	171 (16.19)	234 (25.11)	184 (21.52)	589 (20.72)
Very good	102 (9.66)	71 (7.62)	58 (6.78)	231 (8.13)
Good	321 (30.40)	291 (31.22)	231 (27.02)	843 (29.65)
Neutral	225 (21.31)	141 (15.13)	153 (17.89)	519 (18.26)
Poor	122 (11.55)	114 (12.23)	110 (12.87)	346 (12.17)
Very poor	155 (10.89)	81 (8.69)	119 (13.92)	315 (11.08)
Total	1056 (100)	932 (100)	855 (100)	2843 (100)

Being away items:

- spending time in the woodlands gives me a break from my day-to-day routine
- the woodland is a place to get away from the things that usually demand my attention.

Fascination items:

- there is much to explore and discover in the woodlands
- my attention is drawn to many interesting things when I am in the woodlands.

Participants were asked to scale the above items from 0 to 10, where 0 denoted 'not at all' and 10 denoted 'completely'. Measures for each of the being away scale and the fascination scale were then created by calculating the mean of the two items within each category. This yielded two continuous variables ranging between 0 and 10, with a higher score representing a participants' better restorative experience of the woods. *Appendix 5* shows the complete data for all outcome variables described.

Patterns of stress in the study sample

In this section we describe the unadjusted patterns of our primary outcome: perceived stress. We then examine these patterns of stress in accordance with the levels of participants' engagement with natural environments, as measured by the degree of participants' visits to, and visual contact with, woodlands and green spaces.

Unadjusted patterns of stress

Table 14 reports the unadjusted patterns of stress levels of participants by study arm in the cross-sectional data set (panel A) and longitudinal cohort sample (panel B). As described earlier, because our self-reported

TABLE 14 Unadjusted patterns of perceived stress (PSS) for panel A (cross-sectional) and panel B (cohort) sample

Wave	Site		Mean difference (SD)
	Intervention	Control	
Panel A: cross-sectional sample			
1	12.2 (6.4)	14.3 (5.8)	2.1** (0.27)
2	13.5 (6.6)	13.9 (6.6)	0.37 (0.32)
3	14.9 (6.8)	13.2 (7.3)	–1.8** (0.35)
Panel B: cohort sample			
1	13.8 (6.7)	15.0 (5.6)	1.3* (0.5)
2	14.2 (7.1)	14.3 (6.5)	0.14 (0.75)
3	15.5 (7.6)	13.3 (7.3)	–2.3** (0.75)

*$p < 0.01$, **$p < 0.001$.

measure of PSS is a continuous variable, we report means in stress (where a higher number indicates a greater level of stress).

Overall, there are similar unadjusted patterns of stress in the cross-sectional and cohort samples. On average, participants living in the intervention sites had lower stress levels than those in the control sites at wave 1 in both panel A and panel B data sets. These differences were statistically significant, as reflected by the test of equality of means reported in final column of *Table 14*.

By the post-physical intervention survey (wave 2), the unadjusted patterns of stress between the two groups had moved in opposite directions. Intervention site participants became, unexpectedly, more stressed on average. This pattern was more pronounced in panel A than in panel B. For example, although panel A showed a rise of 1.3 in the measure of perceived stress for the intervention participants, panel B showed an increase of about 0.4. There was a moderate reduction in stress for the control sites: a pattern that was observed in both and panel B, with a decrease of stress of approximately 0.4 and 0.7 respectively.

Finally, in the post-social-intervention survey (wave 3), we observed the effect of a similar trend in stress levels as at wave 2. Stress levels for the intervention participants had again risen, whereas those in our control participants had again decreased. Among the intervention site panel B participants, there was a rise of 1.7 in the measure of stress (PSS) by wave 3 over baseline levels. A greater PSS score increase of 2.7 over baseline by wave 3 was detected in panel A (see *Table 14*). In contrast, mean stress levels in the control sites for both panels were lower post social intervention (wave 3).

Unadjusted patterns of stress based on levels of physical and visual engagement with natural environments

Unadjusted patterns of stress by levels of physical and visual engagement with natural environments were considered for both panel A and panel B, comparing intervention and control groups. Physical engagement with natural environments was defined by nature visits as described in *Preparing outcome variables for analysis*, that is, whether or not participants had visited the local woods or other green spaces in the previous 12 months at each survey wave. Visual engagement with natural environments was defined by nature views as described in *Preparing outcome variables for analysis*, that is, whether or not participants were aware of views to natural environments while walking in the neighbourhood.

Post intervention (waves 2 and 3), there was an increase in stress within the intervention groups, regardless of whether or not they had physical or visual engagement with the natural environment. However, when stratified by nature visits, these PSS score increases were greater in the intervention participants who did *not*

undertake nature visits throughout the study (non-nature visits group) than in those who did undertake nature visits. When considering nature views, at wave 2 there was a marked increase in stress in the nature views group at intervention sites in both panels, which was not apparent in the non-nature views group for intervention sites. By contrast, at wave 3 the non-nature views group in the intervention sites showed sharp increases in PSS scores, whereas the nature views groups saw PSS scores fall in comparison with wave 2. The full unadjusted data for these variables are reported in *Appendix 6*.

These initial analyses suggested that the detrimental unadjusted pattern in stress established in *Patterns of stress in the study sample* for intervention sites may have been driven more by participants who were not affected by the intervention. For instance, in the cohort sample (panel B) there was an increase of 2.7 in mean PSS score within the non-nature visits group between wave 1 and wave 3, whereas there was only an increase of 0.7 in mean PSS score within the nature visits group. However, these unadjusted analyses do not take into account either individual-level characteristics or between-site differences in sample composition, and so the more detailed reporting of outcomes, as set out below (*Is the intervention associated with changes in the primary outcome of perceived stress?* to *Sensitivity analysis*), is based on models adjusted to take such variables into account.

Is the intervention associated with changes in the primary outcome of perceived stress?

As described in *Chapter 2, Core survey of community residents*, two general approaches informed the detailed statistical analysis undertaken.

First, an overall effect was estimated – an ITT approach – to test whether or not living in the intervention sites alone was sufficient to produce health benefits regardless of an individual's reported exposure to the intervention. This was considered for both wave 2 and wave 3 data.

Second, we augmented this analysis by examining the differential impact of the WIAT programme as a function of three main factors: (1) self-reported levels of engagement with the natural environment (nature visits and nature views), (2) gender and (3) distance to the woods. A three-way interaction term was added in the models, denoted by the binary variables of type of site (i.e. intervention or control) and survey wave plus the corresponding indicators on engagement with nature, gender or distance to the woods. The interaction term assessed the extent to which the main effect varied by engagement with nature, gender or distance to the woods.

To ease interpretation, most analyses produced adjusted predicted means or probabilities to highlight the substantive impacts of any interaction. These are presented graphically (see *Figures 7–15*).

The two sets of analyses involved a series of multilevel regression models to take account of the fact that observations made on the same individual at two different waves were likely to be correlated. Given the continuous and binary forms of our different outcome measures, the analysis involved a combination of linear and logistic regressions. *Core survey of community residents* sets out the imputation techniques used to handle missing data and prepare the two panels for analysis: panel A (cross-sectional data) and panel B (cohort data).

Results of adjusted models

The multilevel models presented for the ITT approach were adjusted for participants' age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: $\leq$ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey. The augmented models included all these covariates plus binary variables for nature visits in the past year ('yes'/'no') and gender.

Overall effect: intention-to-treat approach

The results of the adjusted models using the ITT approach are presented in *Table 15*. We report only the coefficients for the interaction terms of type of site, that is, intervention or control (reference group: control arm) and wave of survey (reference group: baseline, wave 1). As described before, these interaction terms captured the differential impact of the intervention during the follow-ups. Dichotomised variables for type of site and survey wave were also included in all the models. Results based on the cross-sectional data set can be seen under panel A, whereas panel B shows the results using the longitudinal cohort.

Based on the cross-sectional analysis (panel A; see *Table 15*), stress levels in participants from intervention sites increased during the follow-ups (waves 2 and 3) compared with those in the control groups. The magnitude of the intervention effect was different at each wave, with larger observed changes at wave 3 [*B* (unstandardised coefficient) 3.58, 95% CI 2.85 to 4.31; $p < 0.001$] than at wave 2 (*B* 1.52, 95% CI 0.78 to 2.27; $p < 0.001$). These differences between intervention and control sites across the two post-intervention phases were statistically significant [as measured by the *p*-value (< 0.001) using the Wald test].

The adjusted predicted means of the PSS scores for the two groups, intervention and control, are shown in *Figure 7*. The size of the intervention effect is noteworthy. With regard to the baseline (predicted mean of PSS score = 12.09), by wave 2 (predicted mean of PSS score = 13.5) the predicted mean of the PSS scores within the intervention sites increased by approximately 1.5, and by wave 3 (predicted mean of PSS score = 14.5) a gain of 2.4 was achieved. On the other hand, the predicted means of the PSS scores within the control groups underwent almost no change by wave 2 and a moderate decrease of 1 by wave 3.

The results using the longitudinal cohort (panel B; see *Table 15*) echoed those from the cross-sectional sample. For example, post social intervention (wave 3) a detrimental effect of similar size for the intervention site participants was again established (*B* 3.03, 95% CI 1.54 to 4.52; $p < 0.001$). One important difference between the two sets of results is that the differential impact within the intervention sites post physical intervention (wave 2) was not statistically significant (*B* 1.11, 95% CI –0.46 to 2.68; $p = 0.16$). Overall, the *p*-value (0.004) of the Wald test confirmed the significance of the apparent detrimental effect. The adverse effect was smaller in the longitudinal cohort. Based on the predicted means of the PSS scores (*Figure 8*), from a baseline predicted mean of 13.8, stress levels within the intervention sites increased to 14.1 at wave 2 and 14.9 at wave 3.

TABLE 15 The WIAT intervention effect on perceived stress (ITT approach)

Variable	*B*	*p*-value	95% CI	*p*-value for Wald test
Panel A: cross-sectional sample				
Intervention × wave 2	1.52	< 0.001	0.78 to 2.27	n/a
Intervention × wave 3	3.58	< 0.001	2.85 to 4.31	< 0.001
Panel B: cohort sample				
Intervention × wave 2	1.11	0.16	–0.46 to 2.68	n/a
Intervention × wave 3	3.03	< 0.001	1.54 to 4.52	0.004

B, unstandardised coefficient; n/a, not applicable.

Note

Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

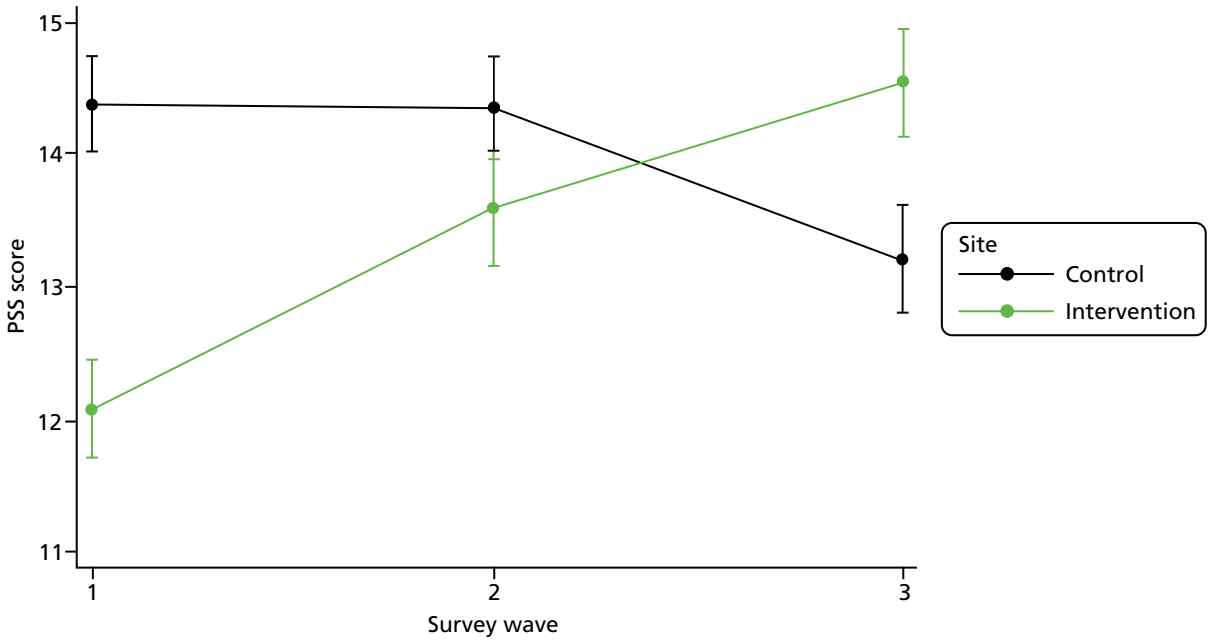

FIGURE 7 Predicted means of PSS scores for panel A: cross-sectional sample. A higher PSS score denotes higher stress, controlling for different individual-level characteristics.

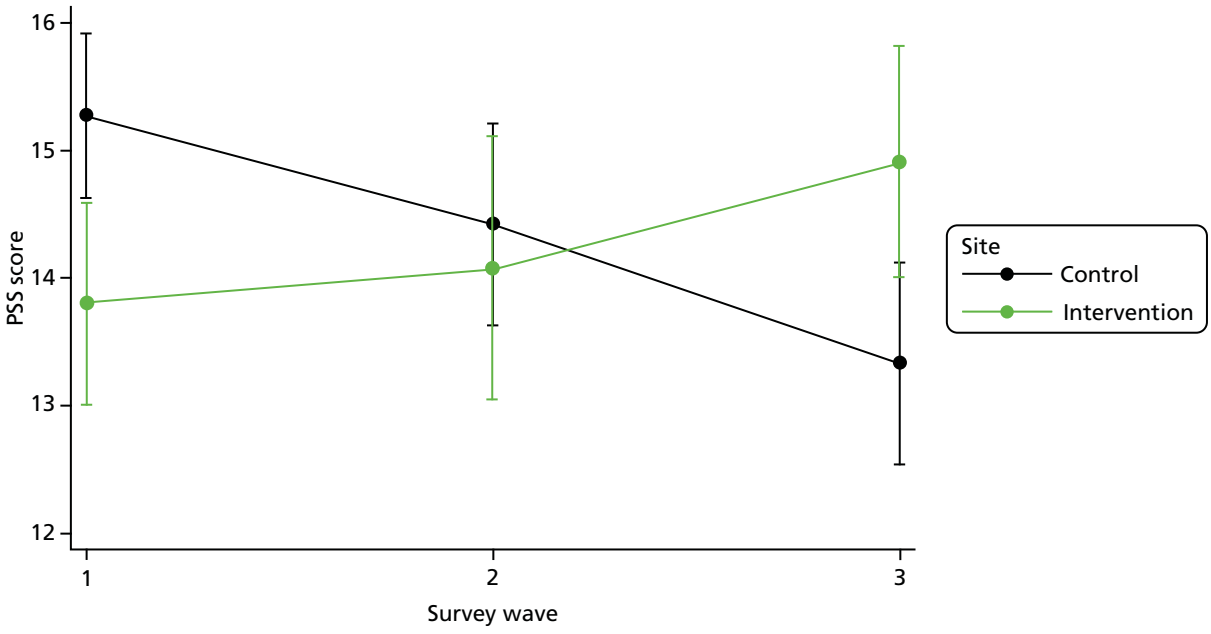

FIGURE 8 Predicted means of PSS scores for panel B: cohort sample. A higher PSS score denotes higher stress, controlling for different individual-level characteristics.

Results for the secondary outcome: mental well-being

To confirm the findings, analyses were repeated with an alternative measure of mental health: the SWEMWBS. SWEMWBS results range from scores of 7 to 35, with higher values denoting more positive mental well-being. The results can be seen in *Table 16*. The signs of all the coefficients for the interactions in both data sets (panels A and B) are negative, thus indicating a similar pattern of change over time in intervention as in the control (i.e. a detrimental intervention effect). *Figure 9* shows predicted means of SWEMWBS using the panel A (cross-sectional) data.

TABLE 16 The WIAT intervention effect on mental well-being (ITT approach)

Variable	*B*	*p*-value	95% CI	*p*-value for Wald test
Panel A: cross-sectional sample				
Intervention × wave 2	–2.20	< 0.001	–2.74 to –1.65	n/a
Intervention × wave 3	–0.57	0.039	–1.10 to –0.03	< 0.001
Panel B: cohort sample				
Intervention × wave 2	–1.92	0.001	–3.06 to –0.78	n/a
Intervention × wave 3	–1.65	0.003	–2.73 to –0.57	0.001

n/a, not applicable.

Note

Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

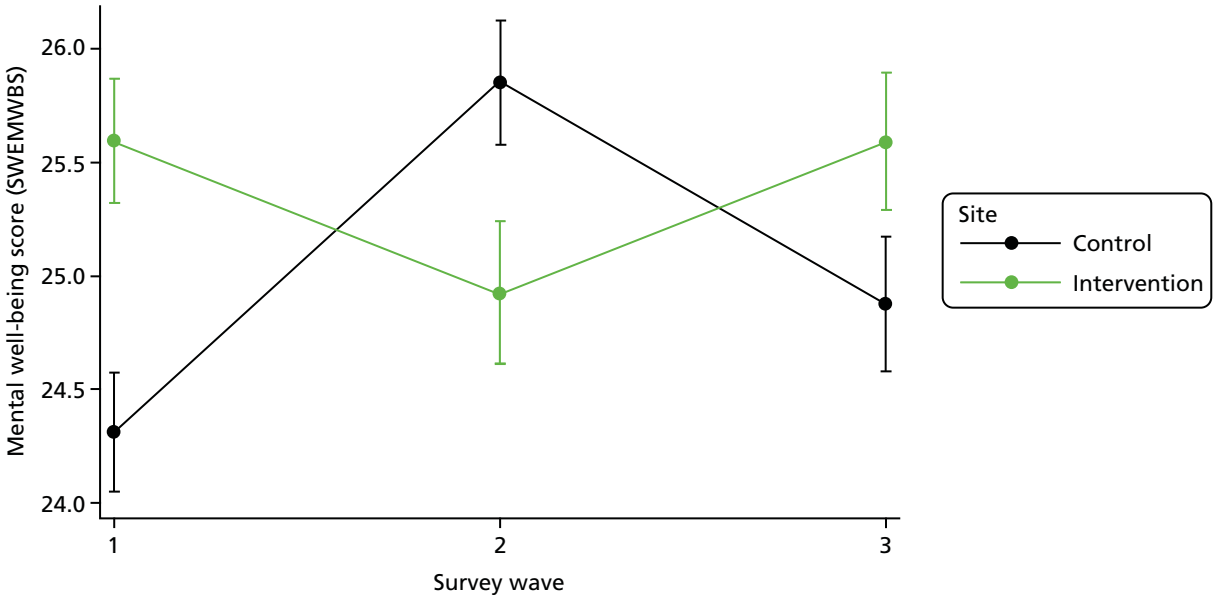

FIGURE 9 Predicted means of SWEMWBS scores for panel A: cross-sectional sample. A higher SWEMWBS score denotes better mental well-being, controlling for different individual-level characteristics.

Do changes in the primary outcome differ in accordance with levels of physical and visual engagement with natural environments?

In *Tables 17* and *18* we refine the analysis to differentiate between participants in accordance with their levels of physical and visual engagement with natural environments. The 'main' intervention effect on stress levels of intervention site participants within each engagement group is reported using both the cross-sectional (panel A) and longitudinal cohort (panel B) samples.

Intervention effect on stress via levels of physical engagement – nature visits

Table 17 supports the notion that the detrimental effect on stress levels within the intervention group seems to be largely driven by participants who were not physically exposed to nature. The cross-sectional analysis (panel A; see *Table 17*) suggested a detrimental intervention effect on intervention site participants who were within the non-nature visits group: their interaction coefficients were positive and highly statistically significant at each point in time (wave 2: *B* 3.04, 95% CI 2.00 to 4.07; $p < 0.001$; wave 3: *B* 4.97, 95% CI 3.95 to 5.99; $p < 0.001$). By contrast, the intervention site participants within the nature

TABLE 17 The WIAT intervention effect on perceived stress by nature visits (augmented approach)

	Wave					
	2			3		
Group	Main effect	*p*-value	95% CI	Main effect	*p*-value	95% CI
Panel A: cross-sectional sample						
Nature visits group	–0.06	0.90	–1.12 to 0.99	1.95	< 0.001	0.89 to 3.00
Non-nature visits group	3.04	< 0.001	2 to 4.07	4.97	< 0.001	3.95 to 5.99
Panel B: cohort sample						
Nature visits group	–0.23	0.83	–2.42 to 1.95	0.64	0.57	–1.60 to 2.88
Non-nature visits group	2.57	0.03	0.3 to 4.83	4.69	< 0.001	2.66 to 6.71

Note
Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

TABLE 18 The WIAT intervention effect on perceived stress by nature views (augmented approach)

	Wave					
	2			3		
Group	Main effect	*p*-value	95% CI	Main effect	*p*-value	95% CI
Panel A: cross-sectional sample						
Nature visits group	1.54	0.003	0.53 to 2.54	2.95	< 0.001	2.00 to 3.91
Non-nature visits group	2.06	< 0.001	0.95 to 3.17	3.75	< 0.001	2.54 to 4.97
Panel B: cohort sample						
Nature visits group	1.57	0.14	–0.52 to 3.66	3.19	0.001	1.30 to 5.09
Non-nature visits group	0.90	0.46	–1.51 to 3.31	2.36	0.06	–0.13 to 4.86

Note
Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

visits group saw a very much smaller increase (*B* 1.9, 95% CI 0.8 to 3.0; $p < 0.001$). Results from the cohort sample (panel B; see *Table 17*) support this. There was no intervention effect on the intervention site participants who were within the nature visits group (wave 2: *B* –0.23, 95% CI –2.42 to 1.95; $p = 0.83$; wave 3: *B* 0.64, 95% CI –1.6 to 2.88; $p = 0.57$) but there was a significant increase in stress levels among the intervention site participants within the non-nature visits group at wave 2 (*B* 2.57, 95% CI 0.3 to 4.83; $p = 0.03$) as well as at wave 3 (*B* 4.69, 95% CI 2.66 to 6.71; $p < 0.001$).

Figure 10 shows the adjusted predicted means of the PSS scores computed using the difference estimates from the model of the cohort sample in panel B of *Table 17*. In the intervention group, from a baseline predicted mean PSS score of 13.6, the non-nature visits group had a predicted mean PSS score of 15.5 by wave 3, whereas those within the nature visits group had a difference of only 0.3 between the predicted mean PSS score at baseline (13.9) and at wave 3 (14.2). The non-nature visits group within the control groups, on the other hand, showed a decline in stress levels from a baseline mean PSS score of 15.4 to 12.6 at wave 3 and, for the nature visits group, a smaller difference in predicted mean PSS from a score of

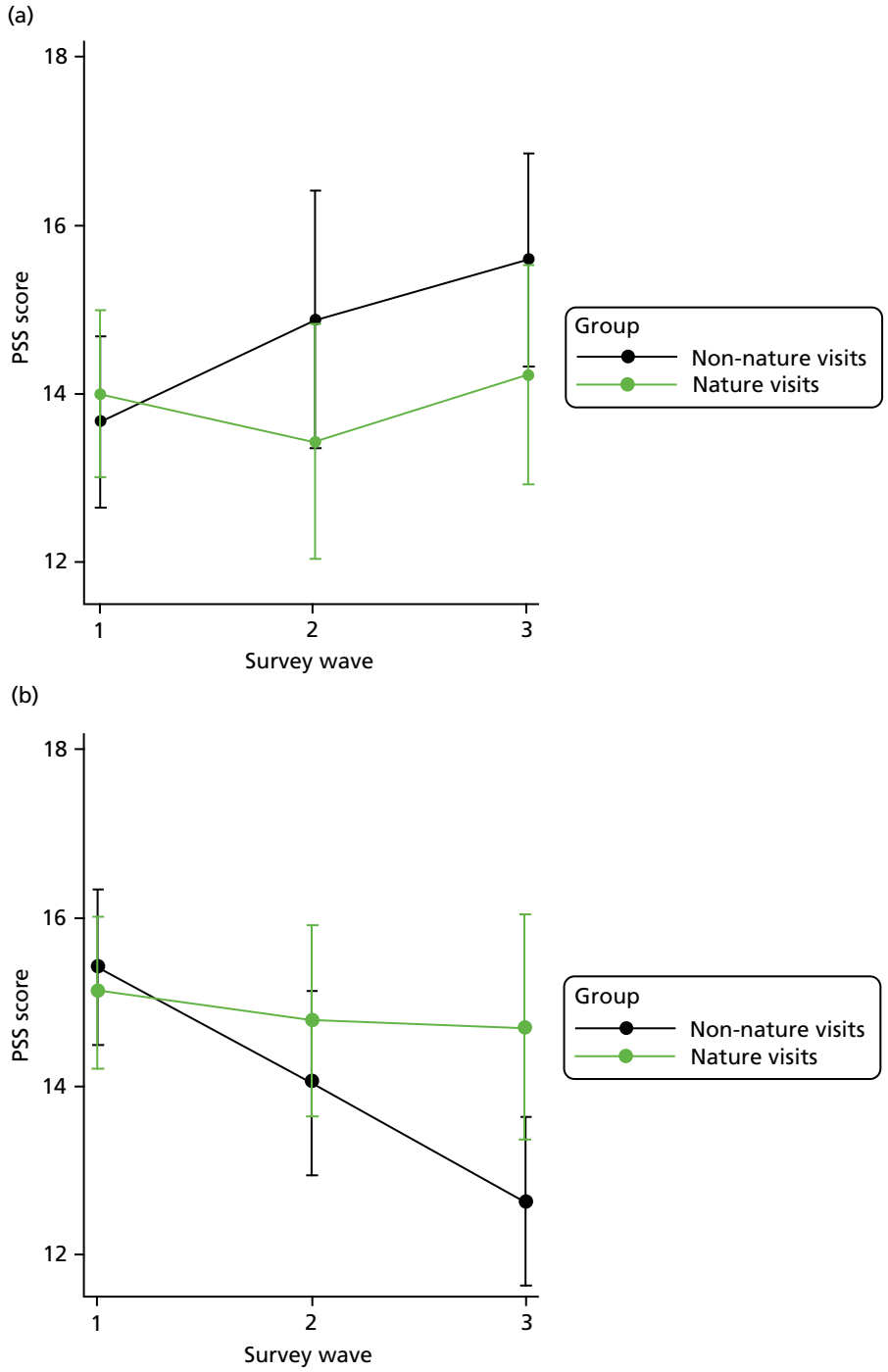

FIGURE 10 Predicted means of PSS scores by nature visits for panel B: cohort sample. (a) Intervention group; and (b) control group. A higher PSS score denotes higher stress, controlling for different individual-level characteristics.

15.1 at baseline to 14.6 at wave 3. It is evident that, although the differential effect of the intervention across the study arms (intervention and control) is not significant in the nature visits group, the effect on the non-nature visits group diverged considerably between intervention and control. This suggests that factors other than those related to visits to natural environments may lie behind the apparent intervention effect on stress levels.

Intervention effect on stress via levels of visual engagement – nature views

The main findings in relation to the intervention effect on stress by levels of visual engagement with natural environments are reported in *Table 18*. There is no simple picture apparent. In panel A, a strong

detrimental effect on intervention site participants was found across both the nature view and non-nature view groups at all follow-up surveys (nature view group: wave 2 – *B* 1.54, 95% CI 0.53 to 2.54; $p = 0.003$; wave 3 – *B* 2.95, 95% CI 2.00 to 3.91; $p < 0.001$; and non-nature view group: wave 2 – *B* 2.06, 95% CI 0.95 to 3.17; $p < 0.001$; wave 3 – *B* 3.75, 95% CI 2.54 to 4.97; $p < 0.001$). However, results using panel B were quite different: a significant detrimental intervention effect for the nature view group was found only at wave 3 (*B* 3.19, 95% CI 1.30 to 5.09; $p = 0.001$).

Adjusted predicted means of the PSS scores from regressions in panel B of *Table 18* are presented in *Figure 11*, which shows increases in the PSS score for the intervention site participants. Within the nature

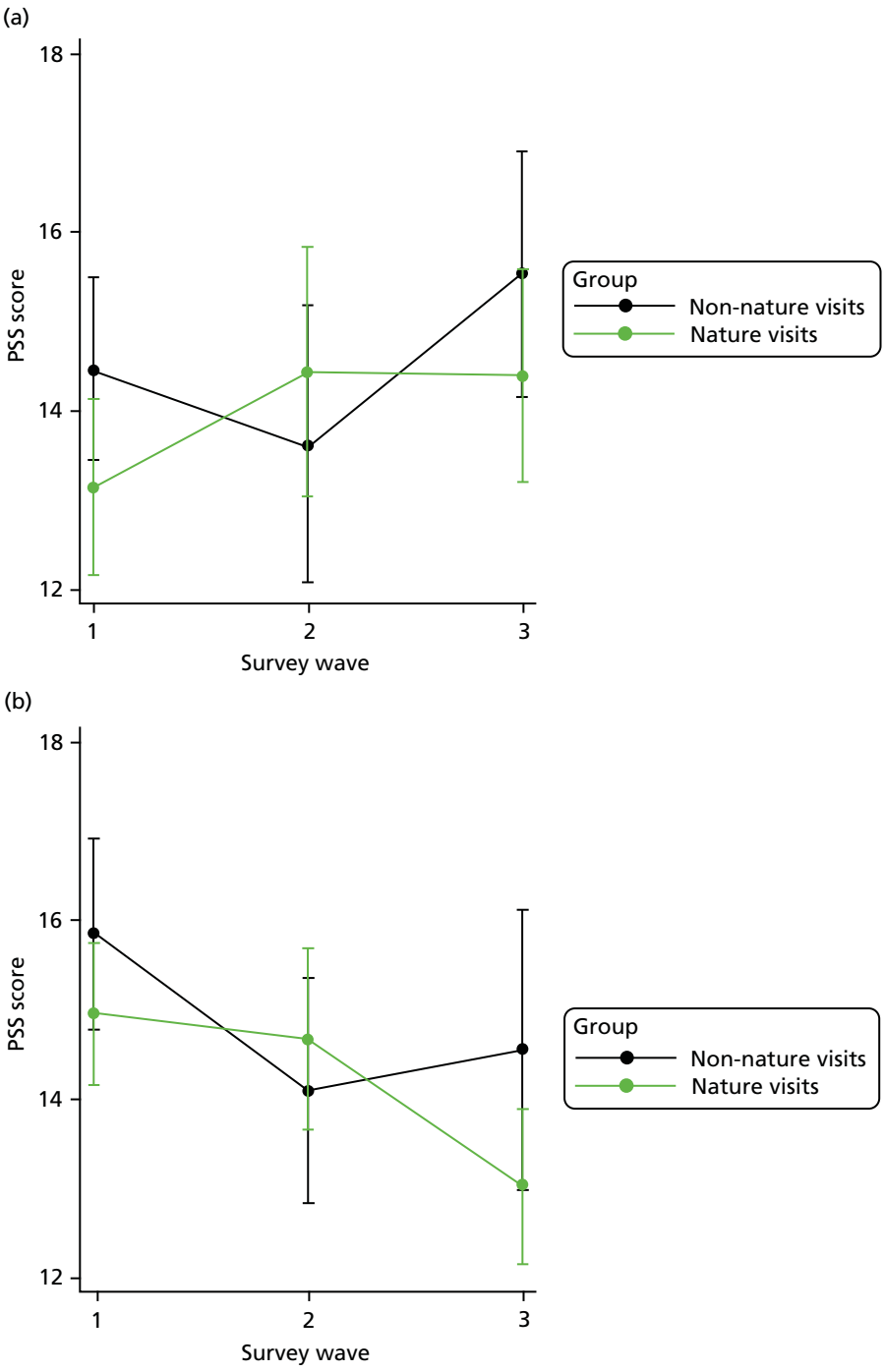

FIGURE 11 Predicted means of PSS scores by nature views for panel B: cohort sample. (a) Intervention group; and (b) control group. A higher PSS score denotes higher stress, controlling for different individual-level characteristics.

views group, predicted mean stress levels among intervention participants were 13.1 at baseline, 14.4 at wave 2 and 14.4 at wave 3. Participants within the control sites, on the other hand, were on average less stressed during the follow-ups, regardless of their degree of visual engagement with natural environments. For example, from baseline to post social intervention (wave 3), those from control sites and in the nature views group were about 2 PSS points less stressed. Results for the non-nature views group were similar.

Intervention effect on mental well-being via levels of physical engagement (nature visits) and visual engagement (nature views)

The same approach was implemented for SWEMWBS as for PSS. The overall results showed that, although there was a detrimental intervention effect associated with those who had undertaken nature visits at wave 2, by wave 3 the effect had become positive, indicating an improvement in mental well-being, but for panel A (the cross-sectional sample) only. By contrast, the intervention effect for those who had not undertaken nature visits was larger, negative and significant at waves 2 and 3 for panel A; this pattern was significant at wave 3 only for panel B (the cohort sample). See *Table 50* for these results.

When the intervention effect was conditioned on nature views, a similar pattern was found as for nature visits. There was evidence of a detrimental effect associated with the intervention site participants with nature views in panel A at wave 2 only, not for wave 3, and no effect was evident in panel B for intervention site participants with nature views. By contrast, for those without nature views, the detrimental effect was larger and significant at both waves 2 and 3 and for both panels (see *Table 51* for these results).

In summary, the evidence here suggests that factors other than those related to visits to natural environments appear to be primarily responsible for the differential patterns of stress observed between intervention and control groups. However, there is some limited evidence that engagement with nature in the intervention group, particularly with regard to visiting natural environments, may buffer stress levels so that the rise of stress over time in this group is less pronounced and in one case (panel B) not significant. However, there is little evidence for this effect in the control group.

Is the intervention associated with changes in the secondary outcomes?

In this section, we present the main findings in relation to changes associated with the intervention to the secondary outcomes. The aim of this analysis was to explore the different potential pathways underpinning the relationship between natural environments and mental health.

Analytical approach

Secondary outcomes were assessed mainly via the ITT approach. As noted before, an ITT approach enabled us to estimate change associated with the WIAT intervention within the intervention arm, relative to the control arm. Furthermore, as with our primary outcome, all secondary outcome analyses were undertaken based on both panel A and panel B. Likewise, when it is deemed relevant, the effect size of the intervention is presented using adjusted predicted means.

Results

Health-related outcomes: physical activity, connectedness to nature and social cohesion

Results can be seen in *Table 19*. They show the significant changes in participants' health behaviours associated with the WIAT intervention programme.

In most of the PA outcomes (e.g. vigorous PA) there was some evidence of an intervention effect. For example, compared with those living in control sites, levels of moderate activity among intervention site participants increased by wave 3. This was observed in both the cross-sectional sample (*B* 249.2, 95% CI 58.25 to 440.10; $p = 0.01$) and cohort sample (*B* 559.3, 95% CI 211.3 to 907.2; $p = 0.002$). Taking the

TABLE 19 The WIAT intervention and health-related outcomes: PA, connectedness to nature and social cohesion

Outcomes	Wave, *B* (95% CI)		Wald test *p*-value
	2	3	
Panel A: cross-sectional sample			
(1) Vigorous activity[a]	–152.9 (–422.6 to 116.8)	221.20 (–43.46 to 485.90)	0.03
(2) Moderate activity[a]	–215.40** (–409.40 to –21.39)	249.20** (58.25 to 440.10)	< 0.001
(3) Walking activity[a]	203.3** (36.81 to 369.8)	–40.87 (–204.50 to 122.80)	0.01
(4) Overall PA[a]	–282.4 (–732.1 to 167.3)	275.2 (–163.2 to 713.5)	0.07
(5) Connectedness to nature[b]	–0.19* (–0.38 to –0.01)	0.39*** (0.20 to 0.57)	< 0.001
(6) Social cohesion[c]	0.44*** (0.22 to 0.65)	0.50*** (0.29 to 0.70)	< 0.001
Panel B: cohort sample			
(1) Vigorous activity[a]	41.24 (–457.4 to 539.9)	382.3 (–87.75 to 852.4)	0.26
(2) Moderate activity[a]	–103.4 (–470.6 to 263.8)	559.3*** (211.3 to 907.2)	0.001
(3) Walking activity[a]	–11.57 (–346 to 322.8)	144.1 (–170.8 to 459)	0.61
(4) Overall PA[a]	–379.8 (–1185.9 to 426.3)	861.5** (106.5 to 1616.4)	0.02
(5) Connectedness to nature[b]	–0.29 (–0.674 to 0.102)	0.15 (–0.22 to 0.51)	0.13
(6) Social cohesion[c]	0.01 (–0.39 to 0.41)	0.02 (–0.36 to 0.39)	0.99

*$p < 0.5$, **$p < 0.01$, ***$p < 0.001$.

a Model estimates shown in terms of MET-minutes per week.

b Model estimates shown based on a visual scale ranging between 0 and 7, measuring participants' sense of connectedness to nature.

c Model estimates shown based on a scale ranging between 3 and 12, capturing participants' community collective strength.

Note

Each row in panels A and B reports interaction coefficients of type of site and wave for separate adjusted models. Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

three PA levels together (vigorous, moderate and walking), intervention site participants appeared, overall, to be more physically active post social intervention (wave 3), as reported by the cohort sample in adjusted model (4) of panel B (*B* 861.5, 95% CI 106.5 to 1616.4; $p = 0.025$).

Figure 12 shows the adjusted predicted means of the total PA score, computed from the difference estimates of the adjusted model (4) of the cohort sample in panel B of *Table 19*. The graph shows an increase among intervention site participants in the total PA score (measured in terms of MET-minutes per week) from baseline to the two follow-ups (waves 2 and 3). It is important to note that the predicted means in the intervention and control sites were almost identical at baseline but that a difference had emerged by wave 3. Compared with the baseline predicted mean of overall PA of 2081.8, intervention site participants' mean PA score by wave 3 was 2727.2, whereas those in the control sites saw mean PA levels drop to 1886.6 by wave 3 from 2102.7 at baseline. At wave 3, the difference between the two groups was notable: on average, intervention site participants had a PA score 841 MET-minutes per week higher than that of the control participants.

Evidence for an intervention effect on the other two health-related outcomes was more mixed. For the cross-sectional sample (panel A), compared with those in the control sites, intervention site participants felt relatively less connected to nature at wave 2 than at baseline (*B* –0.19, 95% CI –0.38 to –0.01; $p = 0.044$),

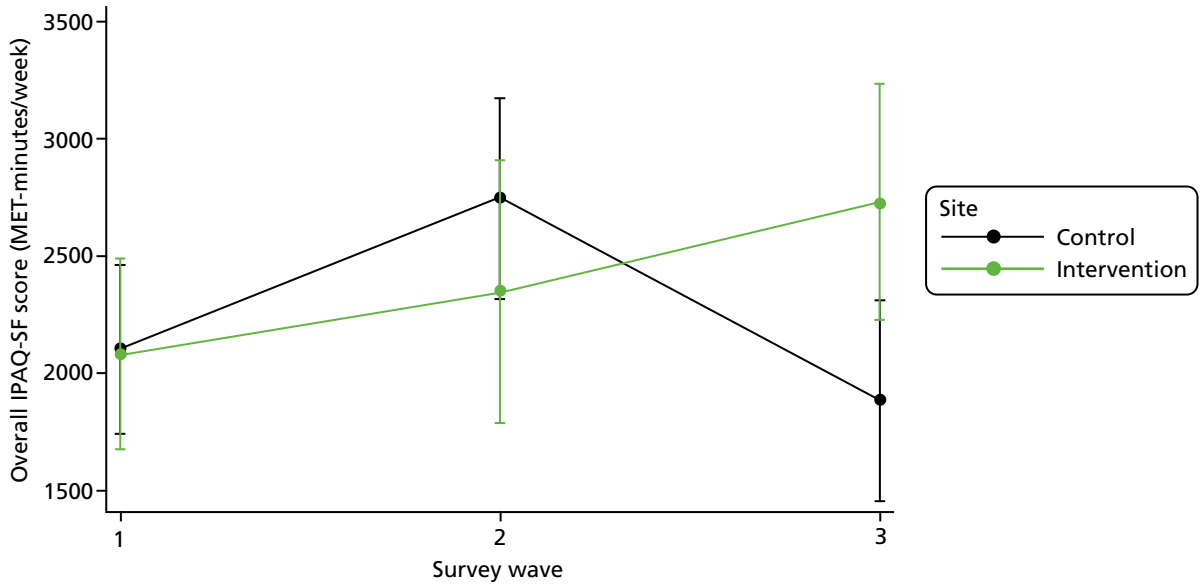

FIGURE 12 Predicted means of overall PA score for panel B: cohort sample. An increase in the total IPAQ-SF score denotes higher levels of PA. Controlled for different individual-level characteristics.

but at wave 3 this was essentially reversed, with intervention site participants feeling more connected to nature than control participants (*B* 0.39, 95% CI 0.20 to 0.57; $p < 0.001$). The pattern was similar but not significant within the cohort sample (panel B).

With regard to social cohesion, based on the cross-sectional data set [adjusted model (6), panel A], the intervention site participants reported stronger levels of social cohesion by waves 2 and 3 than the control site participants (wave 2: *B* 0.44, 95% CI 0.22 to 0.65; $p < 0.001$; wave 3: *B* 0.5, 95% CI 0.29 to 0.70; $p < 0.001$). However, in the cohort sample (panel B) an intervention effect was not detected (wave 2: *B* 0.01, 95% CI –0.39 to 0.41; $p = 0.98$; wave 3: *B* 0.02, 95% CI –0.36 to 0.39; $p = 0.93$).

Behaviour outcomes: nature visits, length and frequency of visits to the local woods, and nature views

Table 20 presents the results for the set of secondary outcomes linked to the behaviour domain. Because all of these behaviour measures were set in binary form, logistic regressions were used. We therefore report odds ratios (ORs) along with their respective CIs and *p*-values. Furthermore, it should be noted that the adjusted models, in which the length and frequency of visits to the woods were estimated, are reported based solely on the cross-sectional data set. This is because these models used only participants who had visited the target woodland areas for the study, and this reduced the sample significantly. For this reason, we were unable to exploit the cohort sample (panel B), which yielded a total sample size of only 314 observations, as models were likely to be overfitted (i.e. with several parameters fitted to a relatively small sample).

The intervention did not appear to have had significant impact on length and frequency of visits to the specified local woods. The panel A analysis showed lower odds of visual contact with natural environments (nature views) for the intervention site participants by wave 3 (OR 0.43, 95% CI 0.31 to 0.59; $p < 0.001$), but the cohort sample did not exhibit a significant effect (wave 3: OR 0.64, 95% CI 0.35 to 1.18; $p = 0.15$). However, there was robust evidence to suggest that intervention site participants were more likely to undertake nature visits more generally than those in the control sites, an effect identified in both panel A and panel B. In both samples this was found post social promotion intervention (wave 3) (panel A: OR 2.69, 95% CI 1.90 to 3.81; $p < 0.001$; panel B: OR 2.77, 95% CI 1.45 to 5.29; $p < 0.001$).

Figure 13 shows the predicted probabilities of undertaking visits to nature computed by using the difference estimates from the adjusted model (1) of the cohort sample in panel B of *Table 20*. A higher

TABLE 20 The WIAT intervention effect on behaviour outcomes: nature visits, length and frequency of visits to the woods, and visual contact with natural environments

Outcomes	Wave, OR (95% CI)		Wald test *p*-value
	2	3	
Panel A: cross-sectional sample			
(1) Nature visits	1.33 (0.94 to 1.88)	2.69** (1.9 to 3.81)	< 0.001
(2) Length of woodland visits[a]	0.43 (0.18 to 1.02)	0.83 (0.36 to 1.90)	0.15
(3) Frequency of woodland visits (summer)[a]	0.79 (0.43 to 1.45)	1.07 (0.57 to 1.99)	0.63
(4) Frequency of woodland visits (winter)[a]	1.45 (0.66 to 3.18)	0.82 (0.38 to 1.77)	0.42
(5) Visual contact with nature	0.88 (0.65 to 1.20)	0.43** (0.31 to 0.59)	< 0.001
Panel B: cohort sample			
(1) Nature visits	1.56 (0.80 to 3.05)	2.77* (1.45 to 5.29)	0.008
(2) Visual contact with nature	1.43 (0.77 to 2.67)	0.64 (0.35 to 1.18)	0.08

*$p < 0.01$, **$p < 0.001$.

a Model uses a reduced sample size because only participants who had visited the target woodland areas for the study were included ($n = 1393$).

Note

Each row in panels A and B reports interaction coefficients of type of site and wave of separate adjusted models. Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

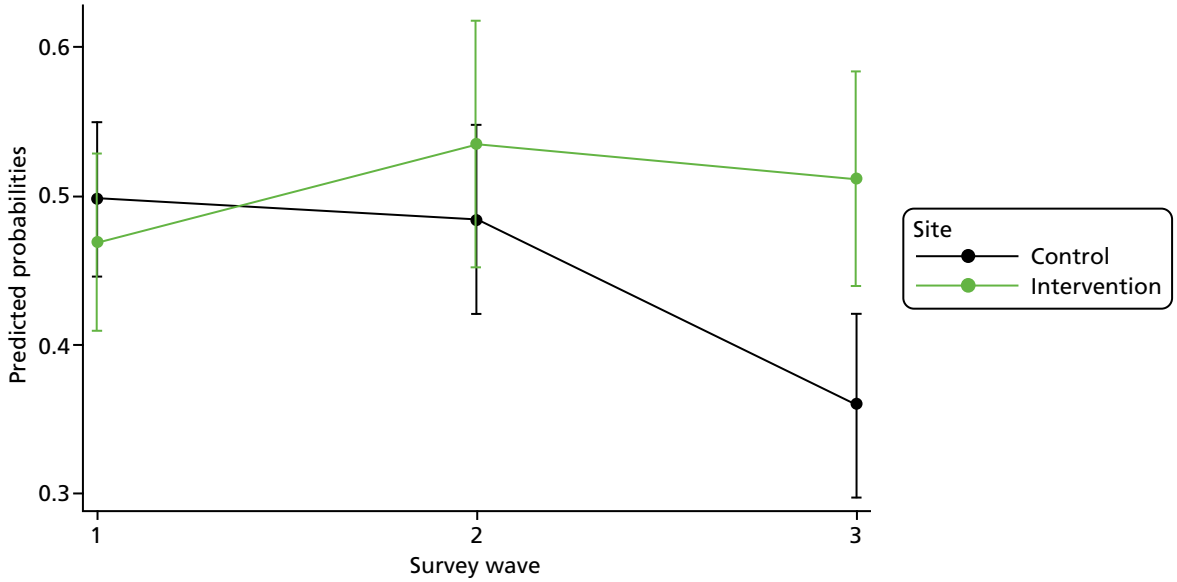

FIGURE 13 Predicted probabilities of nature visits for panel B: cohort sample. A higher predicted probability denotes a higher expected number of individuals visiting nature. Controlled for different individual-level characteristics.

predicted probability indicates a higher expected number of individuals visiting nature. At baseline, both study arms yielded comparable predicted probabilities. However, differences emerged by wave 3. For instance, within the intervention site participants, predicted probability increased to 53% by wave 3, from about 47% at baseline, whereas the predicted probabilities for those in the control sites reduced to approximately 40%, from 51%, over the same period.

We calculated the total increase in the expected number of individuals visiting natural environments by using the intervention site ($n = 20,472$) and control site ($n = 12,615$) populations meeting inclusion criteria from which the random sample was obtained. The effect translated to an additional 1228 individuals within the intervention sites undertaking visits to nature from baseline (expected number = 9622) to wave 3 (expected number = 10,850). By contrast, within the control sites, 1388 fewer individuals were likely to be visiting nature visits by wave 3 (expected number at baseline = 6434; expected number at wave 3 = 5046).

Secondary outcomes related to social support for environment use: awareness of the woods and activities undertaken within the woods

The results for the secondary outcomes associated with social support for woodland use can be seen in *Table 21*. Again, because all of the outcomes used within this category were dichotomised, ORs are reported. Because of the small sample size of participants undertaking activities within the local woods (the total sample size for panel B, as noted above, was only 314 observations) and thus to avoid overfitting models, we present results for these variables based only on the cross-sectional sample (panel A) for estimating changes in the different activities undertaken.

Intervention site participants increased awareness of local woods to a much greater degree than control site participants. The intervention effect was large, held throughout the study (at waves 2 and 3) and was evident in the two sample panels (cross-sectional and longitudinal cohort). For example, using the results from the cohort sample (panel B), the OR for intervention site participants was 3.85 (95% CI 1.92 to 7.72; $p < 0.001$) at wave 2, followed by an OR of a similar size at wave 3: 3.39 (95% CI 1.72 to 6.67; $p < 0.001$). Panel A yielded similar results. *Figure 14* presents the predicted probabilities of awareness of the woods between the two study arms using the difference estimates from panel B (cohort sample).

TABLE 21 The WIAT intervention effect on secondary outcomes related to social support for environmental use: awareness of the woods and activities undertaken within the woods

	Wave, OR (95% CI)		
Outcomes	2	3	Wald test *p*-value
Panel A: cross-sectional sample			
(1) Awareness of the woods	2.26** (1.58 to 3.22)	3.1** (2.15 to 4.46)	< 0.001
(2) Go for a walk[a]	2.98* (1.55 to 5.74)	3.3** (1.73 to 6.29)	< 0.001
(3) Walk a dog[a]	0.53 (0.22 to 1.28)	0.72 (0.30 to 1.70)	0.36
(4) Go out with family[a]	3.42* (1.37 to 8.56)	2.14 (0.91 to 5.03)	0.03
(5) Relax[a]	3.35 (0.61 to 18.28)	1.21 (0.23 to 6.40)	0.30
Panel B: cohort sample			
(1) Awareness of the woods	3.85** (1.92 to 7.72)	3.39** (1.72 to 6.67)	< 0.001

*$p < 0.01$, **$p < 0.001$.

a Model uses a reduced sample size because only participants who had visited the target woodland areas for the study were included ($n = 1393$).

Note

Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

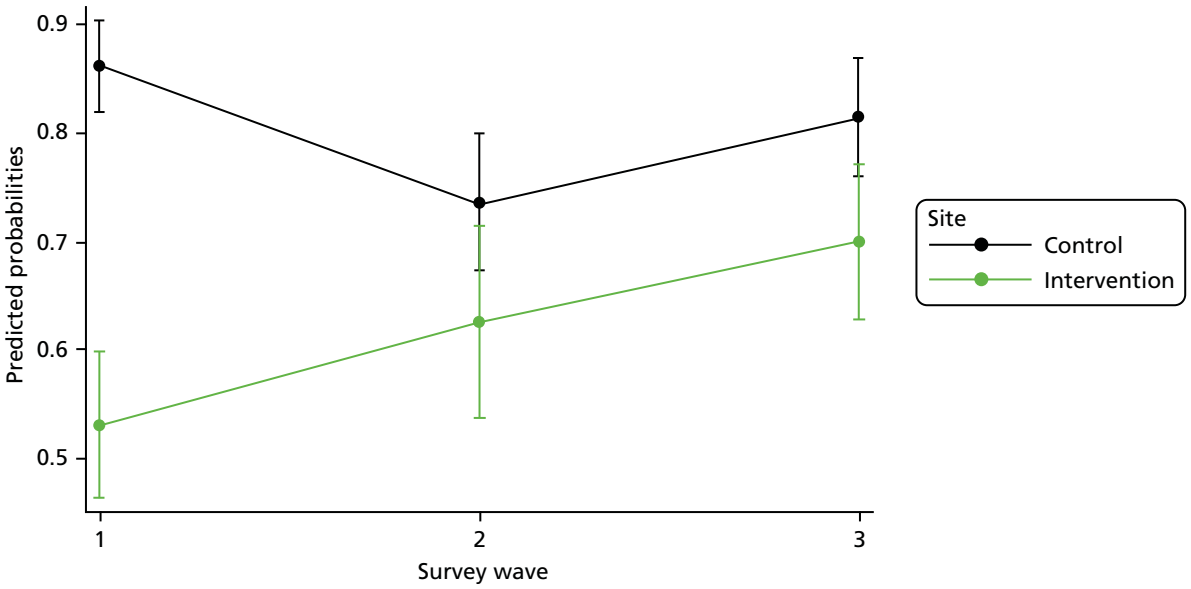

FIGURE 14 Predicted probabilities of awareness of the woods for panel B: cohort sample. A higher predicted probability indicates a higher number of individuals likely to be aware of the woods. Controlled for different individual-level characteristics.

It is interesting to note that participants from control sites were far more aware of their local woodlands at baseline than those from intervention sites but that this declined over time.

Within panel A, an intervention effect on the series of activities undertaken by participants within the woods was evident for the measures of going for a walk and walking with family. With regard to those in the control arm, the odds of going for a walk in the woods for intervention participants were 2.98 (95% CI 1.55 to 5.74; $p < 0.001$) at wave 2 and 3.3 (95% CI 1.73 to 6.29; $p < 0.001$) at wave 3. Similarly, the odds of walking with family for intervention participants were three times that of those in the control arm post physical intervention (wave 2) (OR 3.42, 95% CI 1.37 to 8.56; $p = 0.009$), although this level had dropped by wave 3.

Secondary outcome related to enhanced environment: experience of the woods

Table 22 presents the results in relation to the intervention effect on measures of experience of the woods: being away and fascination scales. An intervention effect was detected for the two measures, but was less apparent at wave 2 than at wave 3. In the cohort sample (panel B), the impact of the WIAT intervention on being away was significant for these measures only post social intervention (wave 3), with a slightly greater effect size (*B* 2.72, 95% CI 1.95 to 3.49; $p < 0.001$) than for the cross-sectional sample.

For the measure of fascination, although the effect was found in both waves 2 and 3, it was significant only at wave 3 in the cohort (panel B) sample (wave 2: *B* 0.62, 95% CI –0.17 to 1.41; $p = 0.12$; wave 3: *B* 2.69, 95% CI 1.94 to 3.43; $p < 0.001$).

Do the intervention outcomes differ in accordance with gender and/or distance to the local woods?

Finally, in the core survey analysis, we explored whether or not the WIAT intervention yielded differences in effect by gender and distance bands to the woods in relation to our primary outcome.

TABLE 22 The WIAT intervention effect on secondary outcomes related to enhanced environment: experience of the woods

Outcomes	Wave, OR (95% CI)		Wald test *p*-value
	2	3	
Panel A: cross-sectional sample			
(1) Being away	0.45* (0.04 to 0.87)	1.99*** (1.59 to 2.39)	< 0.001
(2) Fascination	0.63** (0.24 to 1.03)	2.27*** (1.88 to 2.66)	< 0.001
Panel B: cohort sample			
(1) Being away	0.67 (–0.14 to 1.49)	2.72*** (1.95 to 3.49)	< 0.001
(2) Fascination	0.62 (–0.17 to 1.41)	2.69*** (1.94 to 3.43)	< 0.001

*$p < 0.5$, **$p < 0.01$, ***$p < 0.001$.

Note

Each row in panels A and B reports interaction coefficients of type of site and wave of separate adjusted models. Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

Approach to analysis

To assess the differences in gender and distance bands to the woods, the augmented approach was taken, using the three-way interaction in the models. This enabled us to capture the differential impact of the WIAT intervention on perceived stress as a function of gender and distance to the woods. The main effects of the intervention on stress levels of intervention participants within each subgroup are presented based on the cross-sectional data set (panel A) and cohort sample (panel B).

Gender differences

Table 23 shows the difference estimates for the main effect of the WIAT intervention on stress levels by gender. The difference estimates in the cross-sectional data (panel A) show that, compared with those in the control arm, both male and female participants in the intervention group saw an increase in their stress levels during the two follow-ups (wave 2, female: *B* 1.63, 95% CI 0.67 to 2.58; $p < 0.001$; wave 3, female: *B* 3.42, 95% CI 2.49 to 4.34; $p < 0.001$; and wave 2, male: *B* 1.4, 95% CI 0.24 to 2.57; $p = 0.018$;

TABLE 23 The WIAT intervention effect on perceived stress by gender

Gender	Wave					
	2			3		
	Main effect	*p*-value	95% CI	Main effect	*p*-value	95% CI
Panel A: cross-sectional sample						
Female	1.63	0.001	0.67 to 2.58	3.42	< 0.001	2.49 to 4.34
Male	1.40	0.02	0.24 to 2.57	3.80	< 0.001	2.63 to 4.99
Pane B: cohort sample						
Female	1.27	0.2	–0.66 to 3.21	3.58	< 0.001	1.70 to 5.46
Male	0.82	0.55	–1.86 to 3.51	2.02	0.1	–0.38 to 4.41

Note

Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control), wave of survey and binary variable for gender.

wave 3, male: *B* 3.8, 95% CI 2.63 to 4.99; $p < 0.001$). This detrimental effect was confirmed in the cohort sample (panel B) for female participants only (wave 3: *B* 3.6, 95% CI 1.7 to 5.4; $p < 0.001$).

To add further insight about the effect size of the intervention, the predicted means of PSS scores are plotted by gender and study arm for the cohort sample (panel B) in *Figure 15*. It is notable that stress levels for women and men overlapped at each point in time, suggesting no significant differences by gender.

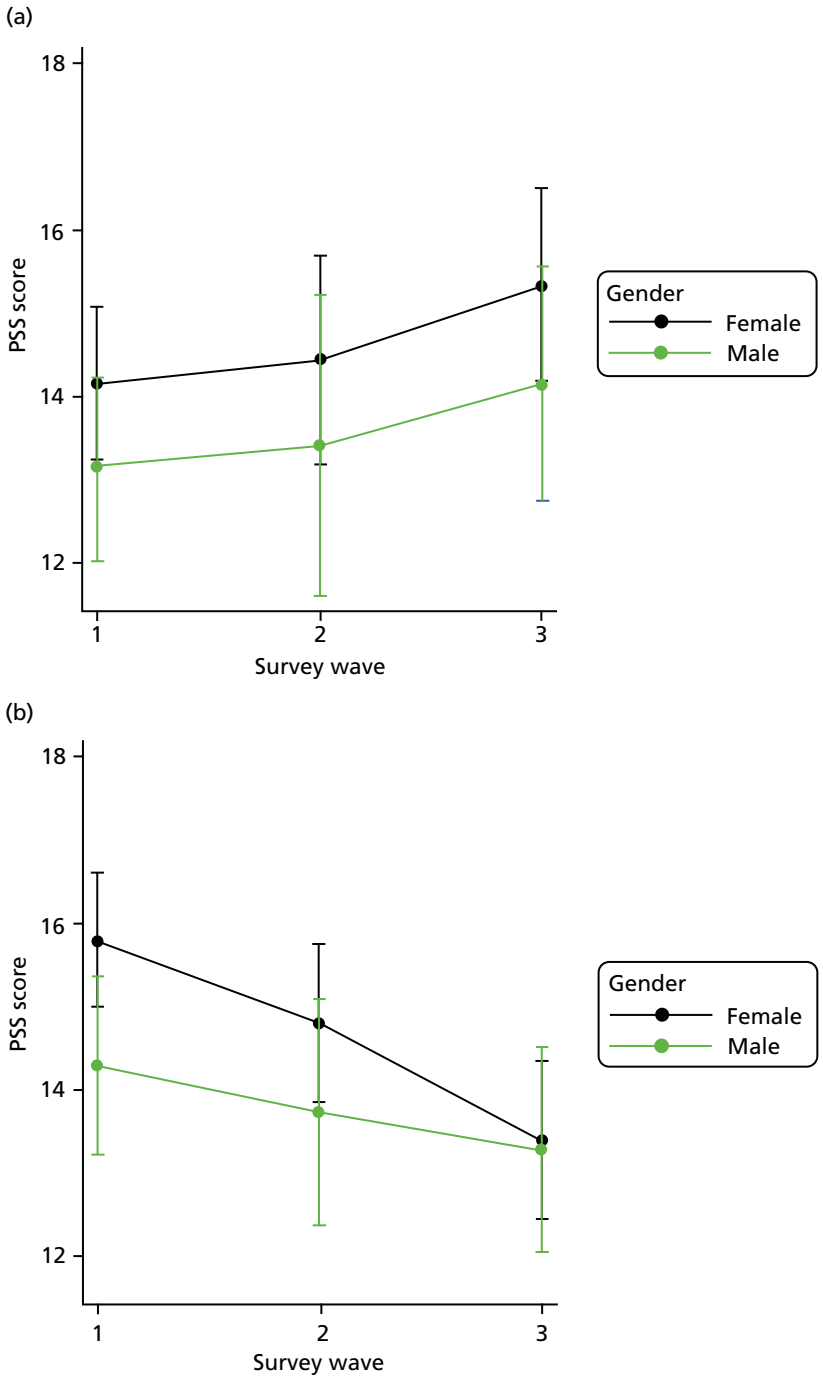

FIGURE 15 Predicted means of PSS scores by gender for panel B: cohort sample. (a) Intervention group; and (b) control group. A higher PSS score denotes higher stress. Controlled for different individual-level characteristics.

Distance bands to the local woods

The difference estimates for the sample stratified within the different distance bands to the local woods are presented in *Table 24*. Based on the cross-sectional data set (panel A), we found that intervention participants within the lower distance bands had a lesser increase in their stress levels relative to those within the upper distance bands than control participants. This pattern was evident after each phase of intervention. For instance, at wave 2, the difference estimate for the lowest distance band (≤ 150 m) was a PSS score of 2.66 (95% CI 0.30 to 5.02; $p < 0.001$) compared with the estimate of 6.47 for the highest distance band (751–1500 m) (95% CI 4.4 to 8.5; $p > 0.001$). The gap between estimates for the lower and upper bands widened further by wave 3 with a difference score of 2.43 for the lowest distance (≤ 150 m) (95% CI 0.32 to 4.53; $p = 0.024$) compared with 9.71 for the highest distance band (751–1500 m) (95% CI 7.28 to 12.13; $p < 0.001$).

The intervention effect was less apparent in the cohort sample as few of the estimates for distance bands were statistically different from zero. However, it is notable that the estimates of difference in PSS score within the upper distance bands (501–750 and 751–1500 m) were some of the highest in magnitude and better in their precision as reflected by their *p*-values and CI, but only at wave 3.

Some of the close distance bands (151–300 and 301–500 m) did not show the trend noted above (i.e. the closer to the woodland area, the lesser the detrimental effect). Although the number of observations within each group was well balanced for both panel samples as a whole, there was a smaller sample size within the intervention sites for the group located ≤ 150 m to the woods ($n = 191$, panel A at baseline) than within the control sites ($n = 809$, panel A at baseline). To address this imbalance in sample numbers, two strategies were then implemented. First, we merged the lowest two distance groups (≤ 150 and 151–300 m), so that four groups were formed for analysis (≤ 300, 301–500, 501–750 and 751–1500 m). Second, distance groups 151–300 and 301–500 m were merged to create a different set of four groups for analysis (≤ 150, 151–500, 501–750 and 751–1500 m). Results from both of these analyses reinforced the trends reported earlier, with lower bands showing a lesser increase in stress levels and the opposite within the upper bands. The full results are shown in *Appendix 6*.

TABLE 24 The WIAT intervention effect on perceived stress by distance bands

	Wave					
	2			3		
Distance bands (m)	Main effect	*p*-value	95% CI	Main effect	*p*-value	95% CI
Panel A: cross-sectional data set						
≤ 150	2.66	0.03	0.30 to 5.02	2.43	0.02	0.32 to 4.53
151–300	0.66	0.50	–1.22 to 2.55	4.30	< 0.001	2.53 to 6.06
301–500	2.31	0.01	0.63 to 3.98	0.91	0.29	–0.77 to 2.60
501–750	3.00	< 0.001	1.38 to 4.64	4.15	< 0.001	2.49 to 5.81
751–1500	6.47	< 0.001	4.43 to 8.50	9.71	< 0.001	7.28 to 12.13
Pane B: cohort sample						
≤ 150	4.99	0.05	–0.006 to 9.900	5.08	0.05	–0.09 to 10.26
151–300	–0.50	0.80	–4.24 to 3.25	2.93	0.09	–0.49 to 6.35
301–500	2.32	0.21	–1.29 to 5.93	2.98	0.17	–1.30 to 7.26
501–750	3.19	0.04	0.17 to 6.21	4.45	0.002	1.66 to 7.24
751–1500	3.54	0.07	–0.31 to 7.38	6.31	0.003	2.18 to 10.44

Note
Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

Sensitivity analysis

Sensitivity analyses on the above results were carried out. Crucially, these all yielded similar findings to the results documented above. Sensitivity was tested as follows:

- First, and in light of the problematic cases in the original sample with an unreliable PSS score, a more conservative sample was in place when modelling perceived stress and all other outcomes. We omitted participants whose PSS score was zero, with the assumption that a zero value was in effect a refusal from participants to engage with this measure.
- Second, we ran all the analyses for the secondary outcomes again, but this time with the problematic cases included in the data, given the fact that these cases were mainly showing questionable information linked to the primary outcome.
- Third, as well as conducting the analysis on the basis of the multiple imputation data, complete-case analyses were also used (not reported here) in a similar fashion to confirm that the findings were robust.

Summary of results

In summary, although there was evidence (via the ITT approach) that, relative to those in the control sample, the intervention was associated with increased stress levels, this detrimental effect was principally found in intervention participants whose nature visits (to woodlands and other nearby green spaces) were negligible throughout the study (as reflected by the augmented approach to analysis). Furthermore, we found that stress levels for the intervention sample increased sharply over time for those living at a greater distance from the woodland areas, whereas for those living within 500 m of their local woodland the increase in stress levels was less pronounced. This suggests that factors unrelated to the WIAT intervention played some role in promoting the detrimental patterns and levels of stress for participants within the intervention sample by the time of the wave 3 survey.

However, the intervention was associated with improvements in most of the secondary outcomes hypothesised as potential pathways in the relationship between natural environments and mental health. We found significant changes in aspects of all the health-related outcomes (i.e. PA, connectedness to nature and social cohesion). For example, a differential effect between the intervention and control groups was detected in most of our measures of PA [i.e. in moderate activity, walking (panel A only) and overall PA]. Intervention site participants in our cohort (panel B) sample had, on average, a better overall PA score (B 861.5, 95% CI 106.5 to 1616.4; $p = 0.025$) post social intervention (wave 3).

Other behaviour outcomes also revealed positive associations with the intervention. We found a greater increase in the adjusted probabilities of nature visits for participants in the intervention sample than in the control sample (i.e. a significant rise in the number of individuals predicted to visit local woodlands or other green spaces). Furthermore, there was evidence of an association between the intervention and the secondary outcomes related to social support for environmental use via community engagement. For instance, a significant and large intervention effect was found in relation to the degree of participants' awareness of the local woods: the odds of intervention participants being aware of the local woods were three times that of participants in the control arm post both phases of the WIAT intervention. The WIAT intervention was also effective in enhancing the experience of the local woods for intervention participants, because both of our perceived restorativeness measures (i.e. being away and fascination scales) yielded positive changes within the intervention sample after the intervention.

Finally, significant differences in gender were also explored in relation to the impact of the WIAT intervention on the primary outcome. We found that, on average, women showed consistently greater stress levels than men, although this gender difference was not significant. The intervention was associated with increased PSS in both men and women within the intervention sample, whereas stress patterns were the opposite in the control sample (i.e. they declined in both men and women post intervention).

Chapter 4 Results from site audits and community focus groups and interviews

The site environmental audits collected throughout the project, from pre to post intervention, and the focus groups and interviews with local community members carried out after the interventions were all completed, were designed to elicit a greater understanding of local community perceptions and experiences.

Although a formal process evaluation was not appropriate given the nature of the intervention, the analysis addressed some aspects of the process as identified by Medical Research Council (MRC) guidance.[35] The environmental audits considered how the local communities perceived their physical environment over time, from 2013 to 2015, whether or not their local woodlands received any WIAT intervention. The focus groups and interviews focused on the intervention sites only and considered how the community perceived their local woodlands, the implementation of the intervention and what was delivered, and the extent to which the community came into contact with the intervention (reach). The focus groups and interviews also considered factors external to the intervention that might have influenced its implementation and/or impact (context).

As context for this, respondents were asked in the second and third waves of the core survey whether or not they had noticed any changes in the local woodlands and, if so, how they would rate their quality. For the intervention sites, 16% of respondents in wave 2 and 22% in wave 3 had noticed changes; of those noticing changes, 70% in wave 2 and 96% in wave 3 rated those changes good or very positive. For the control sites, 21% of respondents in wave 2 and 19% in wave 3 had noticed changes; of those noticing changes, 47% in wave 2 and 58% in wave 3 rated those changes good or very positive.

Thus, although we were not aware of any interventions undertaken in the control site woodlands, the core community survey revealed very similar levels of perception that changes had taken place in their local woodlands across both intervention and control communities. The core survey data showed a more positive rating of the changes for intervention communities than for control communities and we wanted to explore with community members what might lie behind perceptions of change and assessments of woodland environmental quality over the course of the study.

Environmental audit data

The audit data collected from both expert and community-led audits consisted of seven domains in which perceptions of quality were noted: neighbourhood quality, access/signage, woodland/green space quality, facilities, use, maintenance and management and security/safety. Each domain contained between two and six items, a total of 25 items, and each item was scored using a Likert scale from 1–5 (where 1 = poor and 5 = excellent). There was also an opportunity for auditors to add textual comments under each item or domain.

For each audit completed at each site, the scores were averaged across all community group participants and, separately, across the two expert auditors, for each of the 25 items that form the audit tool (see *Appendix 3*). An average was then calculated for each of the seven domains into which these items fall (maximum mean score of 5 for each domain). A final score, summed over these seven domains (range 7–35), represented the overall quality of the woodland and its immediate surroundings. The higher the score, the better the environmental quality as perceived by the auditors. The textual comments were also reviewed. Although comparatively few participants provided much in the way of comments, when they were provided they were valuable in assisting with the interpretation of the scores and allowed for a clearer understanding of community perceptions of the woodlands. *Appendix 3* contains the detailed results of these audits for each domain and additional data on which figures presented in this section

are based, as well as a summary of textual comments on each site. *Table 25* shows the summary environmental audit scores for the intervention and control sites, year by year, for community-led audits. *Table 26* shows the summary of expert scores.

Table 25 shows that all intervention sites had a final (summer 2015) mean score higher than at baseline, although the community auditors perceived greater improvements in quality in intervention sites A and B than in C. There is greater variability over time in the control site scores, for example with a drop of 10.87 points between winter 2015 and summer 2015 in control site A.

TABLE 25 Summary table: community-led audits, total environmental scores, 2013–15

	Date											
	Winter 2013		Summer 2013		Winter 2014		Summer 2014		Winter 2015		Summer 2015	
Site	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Intervention												
A	14.75	3.55	15.70	3.58	16.95	4.84	21.08	4.66	21.83	3.71	20.13	4.18
B	16.32	2.41	17.73	4.37	18.80	5.06	25.18	2.91	27.73	2.45	24.00	2.48
C	20.39	3.08	19.10	3.34	19.85	3.18	19.70	2.03	20.25	3.87	21.99	3.57
All intervention sites	17.15	3.02	17.51	3.77	18.54	4.36	21.99	3.20	23.27	3.34	22.04	3.41
Control												
A	n/a[a]	n/a[a]	15.81	6.19	19.00	8.63	22.47	9.79	25.87	11.14	15.00	0.00
B	11.04	2.10	11.71	2.21	8.54	1.43	14.25	3.46	14.13	2.65	10.13	3.70
C	13.19	3.43	16.95	4.21	14.20	3.54	18.89	4.60	20.39	3.47	18.23	4.44
All control sites	12.11	2.77	14.82	4.20	13.91	4.53	18.54	5.95	20.13	5.75	14.45	2.71

M, mean; n/a, not applicable.
a No community members were available and willing to audit control site A in winter 2013.

TABLE 26 Summary table: expert audits, total environmental scores, 2013–15

	Date											
	Winter 2013		Summer 2013		Winter 2014		Summer 2014		Winter 2015		Summer 2015	
Site	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Intervention												
A	10.35	0.21	11.24	1.16	18.53	0.29	17.96	1.24	19.88	1.12	19.08	2.12
B	11.75	0.07	13.45	1.48	14.70	0.69	19.79	1.24	21.05	1.71	21.58	0.82
C	12.09	0.37	13.09	1.39	19.45	1.56	19.63	1.83	21.63	0.18	25.54	1.36
All intervention sites	11.40	0.22	12.59	1.34	17.56	0.85	19.12	1.43	20.85	1.00	22.07	1.43
Control												
A	11.48	0.04	11.75	0.32	11.08	1.31	14.17	0.24	13.04	0.53	13.71	1.36
B	11.43	0.39	12.30	1.04	7.98	0.67	12.96	0.77	12.42	0.12	11.04	0.65
C	12.90	0.71	12.50	0.99	11.38	0.67	15.71	1.24	11.38	0.67	15.79	0.53
All control sites	11.93	0.38	12.18	0.78	10.14	0.88	14.28	0.75	12.28	0.44	13.51	0.84

M, mean.

Table 26 shows fewer variations in expert scores between intervention sites than in community auditors' scores. The intervention sites all show increases in score by experts over time, with intervention site C showing the greatest increase by summer 2015. There is some variability in expert scores for different control sites and for these sites over time, but with smaller differences than for the intervention sites.

Seasonality

The winter audits in 2014 and 2015 were undertaken during the implementation of phase 1 and 2 interventions respectively, whereas the summer audits in 2014 were post phase 1 intervention and in 2015 they were post phase 2 intervention. The 2013 audits constitute the baseline, pre-intervention condition in both winter and summer.

Overall, audit scores were not significantly different (Mann–Whitney *U*-test) between summer and winter, for either the community or the expert audits, but it is notable that, for 2013 and 2014 community audits, summer scores were higher than winter scores in all cases but intervention site C. However, by 2015 community auditors scored all sites higher in winter than in summer, with the exception of intervention site C. This pattern is not found in the expert audits and is difficult to explain, other than that (for intervention sites A and B only) it might reflect a lack of maintenance post intervention.

Change over time

There was a significant difference (Mann–Whitney *U*-test) found between mean scores for intervention and control site scores across all time points, for both community ($p < 0.001$) and expert audits ($p < 0.001$). *Figure 16* shows the differences in mean audit scores at each time point for the community audits and *Figure 17* shows the pattern for expert audits.

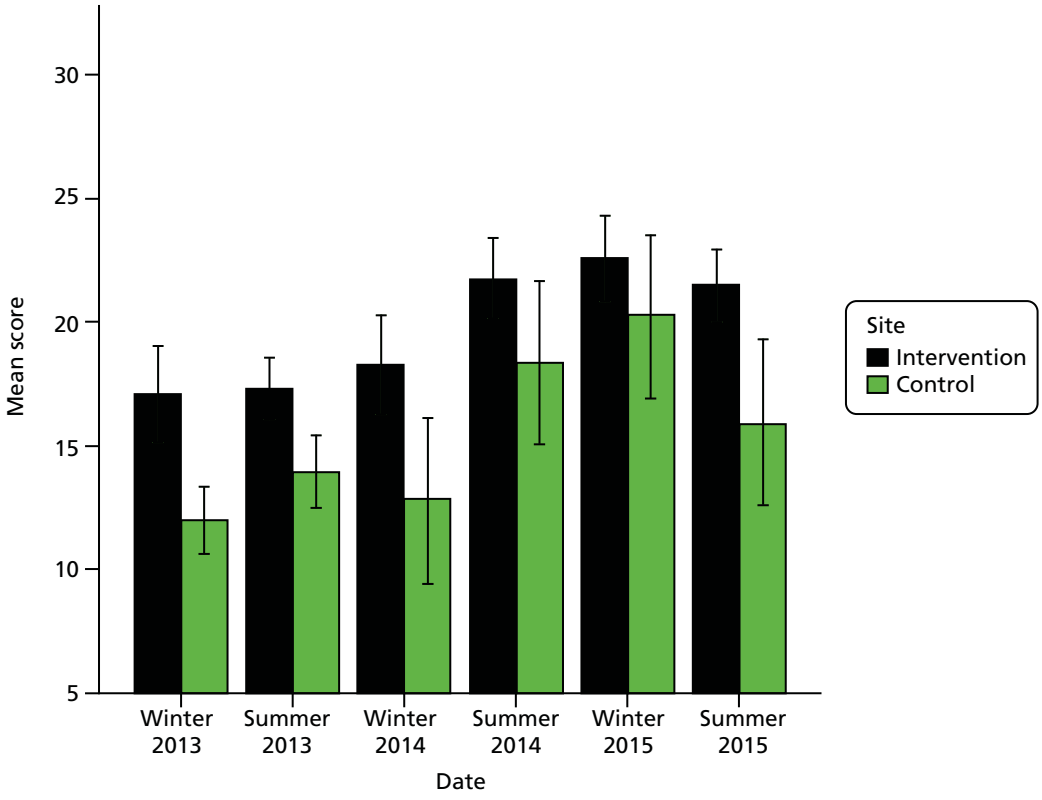

FIGURE 16 Difference between community audit scores for intervention and control sites over time. Error bars represent 95% CIs.

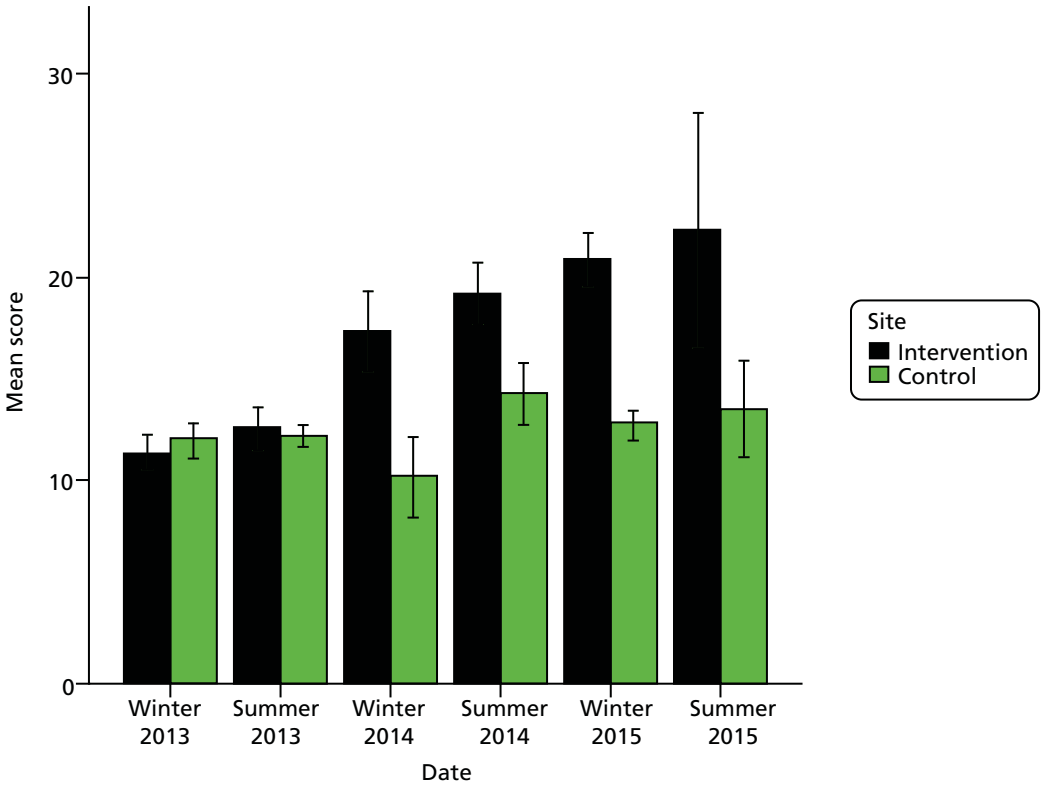

FIGURE 17 Difference between expert audit scores for intervention and control sites over time. Error bars represent 95% CIs.

Figure 16 shows that intervention sites on average achieved higher community audit scores than the control sites at baseline and at all subsequent audits. However, there was a fairly steady increase in mean scores for the intervention sites once the interventions had begun in 2014, whereas the control sites have greater fluctuation in mean scores, having a mean score in winter 2015 of > 8 points higher than in winter 2013 but then dropping considerably in score in summer 2015. By summer 2015, the mean score for the intervention sites had increased by 4.53 points compared with summer 2013, whereas the control sites' mean score had marginally decreased over the same period. The error bars illustrate significant differences between intervention and control in winter 2013, summer 2013, winter 2014 and summer 2015. The pattern shows that, although the quality of all woodland sites was perceived to improve in summer 2014 and winter 2015, by summer 2015 the quality of control sites had declined markedly compared with that of the intervention sites. The intervention sites were also considered to be significantly better quality than at baseline from summer 2014 onwards.

Figure 17 shows that the experts scored intervention and control sites very similarly, on average, at baseline in 2013 and it is only the intervention sites that show any substantial change over time, with a steady increase to a mean score of 9.48 points higher in summer 2015 than in summer 2013. By comparison, the control sites' expert mean score increased by only 1.33 points over the same period. The control sites were scored significantly lower than the intervention sites in all 2014 and 2015 audits by experts, in contrast to the scores from community auditors.

In all but two audits, the community auditors were more positive than expert auditors about both baseline conditions and post-intervention conditions at the intervention sites. The lack of community auditors for one of the audit sessions in control site A may exaggerate the difference between the community and the experts in perceptions of quality over time.

Community audit scores for different environmental domains

Figure 18 shows the mean community audit scores for each environmental domain of the woodland audit averaged across all intervention sites. Winter and summer audit scores have been averaged for each of the 3 years of the study.

Figure 18 shows an increase in quality for the intervention sites across all six domains focused on the woodland, with only the overall neighbourhood quality score showing little change. Facilities show the lowest score at each time point, despite improving over time, whereas overall woodland quality shows the smallest increase over time, followed by woodland safety/security. The greatest increase by 2014 is in woodland management and maintenance, although this had declined somewhat by 2015. The greatest increase in quality between 2013 and 2015 is in woodland access.

Figure 19 shows an increase in quality for the control sites across all seven domains in 2014 but a decline to near baseline level by 2015 in all domains apart from overall neighbourhood quality and woodland safety and security. This last domain is of interest as it might be considered an important aspect influencing people's use of woodlands.

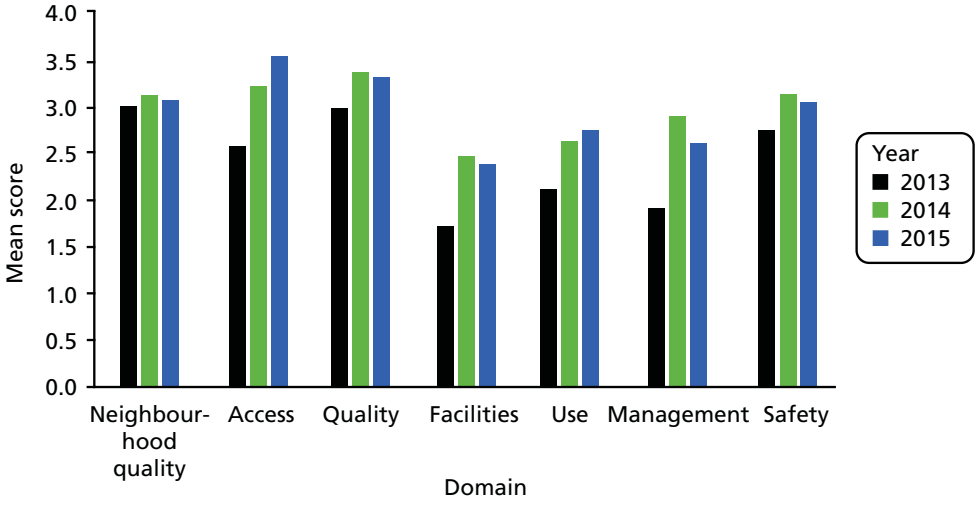

FIGURE 18 Difference in community perceptions of seven domains of woodland quality, 2013–15: intervention sites.

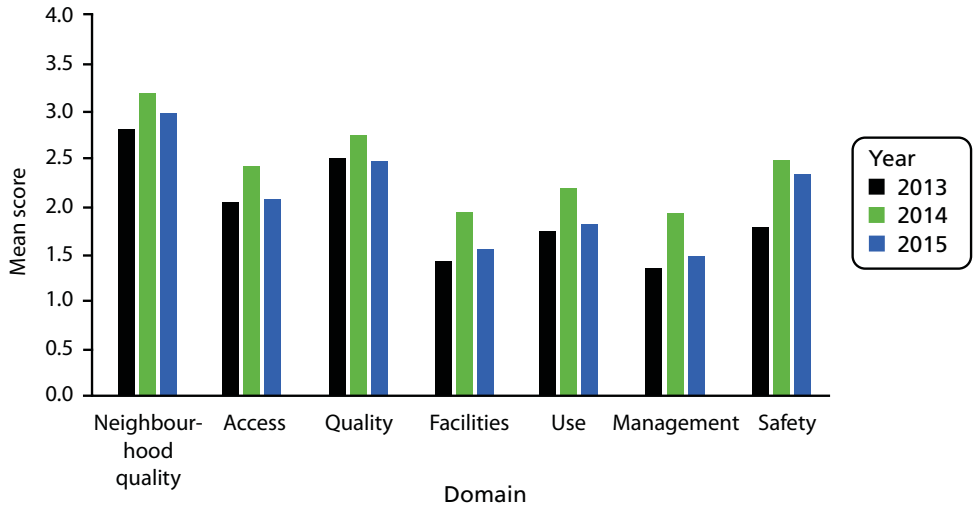

FIGURE 19 Difference in community perceptions of seven domains of woodland quality, 2013–15: control sites.

Perceived environmental change in each intervention site

Appendix 3 gives the scores for each site at each audit point for both community and expert audits. It also summarises the comments made by auditors at each time point in relation to the different domains of the audit tool. In intervention site C, the difference between environmental quality pre and post interventions was evident only in summer audits for community auditors, who judged baseline conditions in winter more positively than the expert auditors. Over time, the pattern and direction of change in environmental audit scores was similar between the community and expert audits in intervention sites A and B, but the pattern varied more for intervention site C. More detailed information on audit scores for each of the intervention sites is given below.

Intervention site A

In the baseline audits, intervention site A was judged to be a relatively poor-quality woodland by the expert auditors, whereas the community auditors were more positive and judged it to be of moderate quality. For the expert auditors, it performed particularly poorly with regard to access: the absence of paths, woodland facilities and woodland management, with dense vegetation creating an unwelcome feeling of enclosure. It was considered moderately good on safety. For the community auditors, the woodland performed least well with regard to woodland management, levels of use and onsite facilities. It was considered to perform very well on neighbourhood quality. At baseline, both sets of auditors were more positive about the woodland in the summer than in the winter.

Most items considered by the audit tool were scored higher in the post-intervention audits than in the baseline audits. Improvements made to the entrance, the new paths, tree management works and the introduction of new seating and tables appeared important in explaining the improved scores. Comments from community auditors included '[it's] much better than it was', 'I felt safer than the last time' (i.e. during the baseline audit), 'wonderful, and path well defined', 'pleasant area – in winter it's quiet' and 'we could picnic here'. In the 2015 audits, both community and expert auditors were more positive about the woodland in winter than in summer.

Scores were lower in the audits completed in 2015 (during and after phase 2) than in 2014 (during and after phase 1). This suggests that the quality of the woodlands had declined over this period. Indeed, auditors reported more signs of vandalism and less evidence of management in the 2015 audits. Community auditors' comments included 'unfortunately, vandalism has taken place on the woodlands sculpture, which was burned', 'lots of litter' and '[trees] could be cut back to have a view'.

Intervention site B

As with intervention site A, in the baseline audits intervention site B was judged to be a relatively poor-quality woodland by the expert auditors, whereas the community auditors were more positive and judged it to be of moderate quality. For both groups of auditors, it performed least well on woodland facilities and woodland management. For the expert auditors, perceived problems included trees lying on the ground, poor drainage, overgrown paths, vandalism and litter. For the community auditors, perceived problems were relatively similar and included litter, dog fouling and vandalism, with individual comments including 'dog fouling is a huge problem', 'dog mess everywhere, litter also – broken glass' and 'overgrown and muddy'. Both sets of auditors were more positive about the woodlands at baseline (2013) in the summer than in the winter. In particular, the expert auditors gave a greatly improved score for neighbourhood quality in summer than in winter. A perceived reduction in litter and the provision of a new sports centre in the community were given as the main reasons for this improved perception.

During and after intervention (phases 1 and 2), an improvement in overall woodland quality was perceived by the expert and community auditors, with the former generally identifying a greater positive change. Almost all the domains included in the audit tool were given a higher score. The delivery of new paths, signage, benches, picnic tables, decking, sculptures and a fitness trail were noted as important in explaining these improved scores. The direction of change was negative in relation to just one domain, woodland safety, and this was true only for the community auditors during and after the phase 2

intervention, in 2015. Despite this, the community and expert auditors were generally more positive about the woodland in 2015 than in 2014, especially in the winter 2015 audits. This suggests that, unlike intervention site A, there had been no obvious deterioration in the quality of the environment over this period. Nonetheless, in the 2015 audits concerns were expressed about the ongoing management of the woodland, with overgrown vegetation, litter and vandalism noted.

Intervention site C

As with intervention sites A and B, in the baseline audits intervention site C was judged to be a relatively poor-quality woodland by the expert auditors, whereas the community auditors were more positive and judged it to be of moderate quality. It performed least well, in the opinion of both sets of auditors, on woodland facilities and woodland management. The woodland's quality was undermined by a lack of paths, overgrown vegetation, no onsite facilities, litter and dog fouling, with community member comments including 'no visible paths at all', 'signage could be improved and no disabled access', 'no benches or toilets' and 'lots of dog dirt and waste'. At baseline (2013), the community auditors were more positive about the overall quality of the woodland and its surroundings in winter than in summer, whereas the reverse was true for the expert auditors.

During and after the intervention (phases 1 and 2), the expert auditors gave the woodland a higher score in all domains considered by the audit tool excluding 'woodland facilities'. The expert auditors perceived little change to woodland facilities, identifying a lack of facilities both at baseline and following the intervention. The community auditors had mixed views on the impacts of the interventions. Despite perceptions of enhanced quality in all audit domains except for woodland quality after phase 1 interventions, during and after phase 2 interventions (2015) the community auditors perceived a decline in quality in various audit domains (neighbourhood quality, woodland quality, woodland facilities and woodland safety) in the winter 2015 audits relative to baseline conditions. However, they perceived an increase in quality in all domains compared with baseline in the summer 2015 audits. In the 2015 summer audits, community members commented that the site was 'very much improved' and the new paths were 'first class'. Although identifying the woodland generally as a good-quality environment, the community auditors continued to identify problems with litter and dog fouling in the 2015 audits: 'unfortunately there is still a lot of fouling on the path'.

Summary

In summary, the site audits show that the interventions were perceived as significantly enhancing the quality of the intervention woodlands compared with baseline, and that this was true regardless of seasonality. They also show that, by summer 2015, after both phases of intervention were completed, the intervention sites were, on average, considered of significantly higher quality than the control sites. However, for the community auditors (not the expert auditors) this had also been true at baseline.

The differences in scores between intervention sites and the commentary on what lay behind scores for different domains give some insight into the aspects of the woodlands that are attractive or a deterrent to community use (see *Appendix 3*). The focus groups and interviews undertaken post intervention give further insight into these concerns for the communities involved in the interventions.

Community focus group and interview findings

The topic guide used for the focus groups and interviews imposed an initial set of themes on the discussions: familiarity with the woodlands, use and perceptions of the woodlands pre and post intervention, awareness and perceptions of the interventions, engagement with any aspect of the interventions (especially the social interventions), impacts of the interventions including any behaviour and/or attitude change, access to the woodlands and reasons for not visiting the woodlands. In this context, it is worth noting that, in wave 3 of the core survey, respondents were asked whether or not they had taken part in an organised activity in the local woodlands in the previous year. Only 2% of those in intervention sites (and 3% in control sites) said 'yes', most of whom had done so with others (e.g. family or friends) and a few with their dog.

Subsequent coding of the focus group and interview transcripts using multiple siftings (as described in *Community focus groups and interviews*) produced a final, overarching thematic framework as set out here (*Figure 20*), which reflects community participants' priorities and preoccupations in relation to the topics discussed. The main themes were awareness of natural open space for public use, barriers to access and use of the woods before the intervention, awareness and experience of the interventions, woodland behaviour and experience post intervention, barriers to use of the woods post intervention and wider neighbourhood issues. These main themes, and subthemes within them, are discussed in turn below in relation to each of the intervention sites. As the focus groups and interviews were undertaken only at the intervention sites, all sites referred to in this section are intervention sites. The respondents are identified as R1, R2 and so on, and noted as male (m) or female (f).

Awareness of natural open space for public use

Knowledge of local natural environments and public access

Participants had varying levels of knowledge about their local woods and general awareness about open space near their communities that offered public access to natural environments.

At focus groups in both 2015 and 2017, most site A participants were unaware of the intervention site woodlands as being publicly accessible, whether before or after the interventions. They also did not appear to know of, or visit, these woods. Once the site was clearly identified to them, one 2015 female participant (R2) noted that it would be 'like 15 minutes' walk' to get there for her. However, participants from site A demonstrated a good understanding of publicly accessible natural environments other than the intervention woodland site, such as a large country park about 20 minutes' walk away or where there was a 'good walk' at a greater distance, up to some small reservoirs and green fields beyond the urban area.

At focus groups in both 2015 and 2017 at site B, there was comparatively good awareness of the local woods both before and after the intervention, especially by dog walkers, including people who drove to the site from beyond the local community to visit it. The car park associated with the adjacent sports centre appeared to make it easy for people to visit from further afield. A participant who had moved to the community only the year before the intervention said:

> *[It's] one of the best places I've stayed in a long time, and I mean, I come from the countryside [. . .] when I came [here] it was great because you can literally go out your back door and you're in the countryside and stuff like that, and there's so many different opportunities.*
>
> *R3, m, site B, 2015*

However, another participant said:

> *I'm amazed at the number of people who don't know it's [the woodlands site's] there.*
>
> *R2, f, site B, 2015*

Site C was well known by most of the participants at focus groups in both 2015 and 2017, although some had not visited before the intervention and a few had stopped visiting by 2017. The participants also showed a good knowledge of other woodlands and green fields around their neighbourhood and a large country park a little further afield, which many visited:

> *There's lots of different places roundabout quite close that you can walk to and you're no going up the hill; maybe that's the thing, it puts people off going up that hill.*
>
> *R3, f, site C, 2015*

> *You should go, it's nice to walk round [the country park].*
>
> *R2, f, site C, 2015*

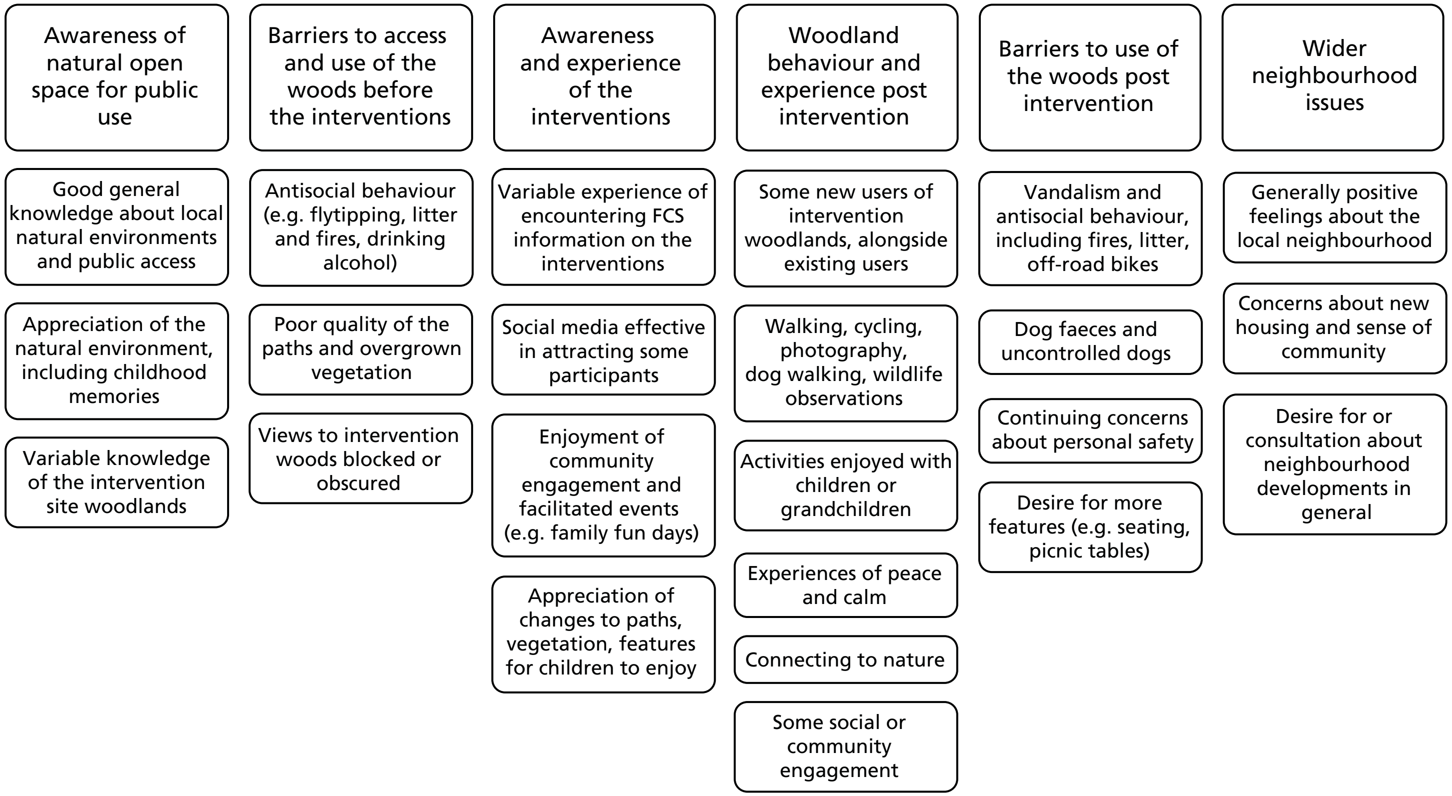

FIGURE 20 Themes arising from focus groups and interviews.

Appreciation of the natural environment, past and present

Participants in sites A and B in 2015 discussed childhood experiences of natural environments, including the local woodlands if they grew up in the local area:

> *[P]layed in them [local woods] when we were weans [children] [. . .] Used to be a horse farm there [. . .] And when the old tenements were there, your ma could keep an eye on you as well.*
>
> *R1, f, site A, 2015*

> *When I was very young [we lived near] a plantation and we went in and made all sorts of things [. . .] you'd maybe climb up and sit on a wee branch or something stupid, stupid now, because you'd be banned from doing it.*
>
> *R1, m, site B, 2015*

> *I grew up not very knowledgeable, but being taught to forage for things [. . .] so I'll take the kids out raspberry hunting, blackberry hunting, looking for strawberries.*
>
> *R2, f, site B, 2015*

In a similar vein, during the 2017 focus groups there were also mentions of the desire to have natural places for participants to take their own children or grandchildren:

> *We're always looking for something, or somewhere, to go with the kids, you know, in the school holidays.*
>
> *R4, f, site A, 2017*

> *I think if you can get the children interested to start with, it probably stays with them for a long time.*
>
> *R1, f, site A, 2017*

There was a common interest in experiencing wildlife and nature across all three sites for focus groups in both 2015 and 2017, with a recognition that the wider neighbourhood offered good opportunities for this:

> *You open your curtains in the morning, and the birds are chirping away [. . .] We get the foxes in our gardens now, and the wee grey squirrels [but] the only place to go roundabout here to see a wild animal is [the nearby country park] to see the deer.*
>
> *R1, f, site A, 2015*

> *[I]t's lovely, I mean the wildlife you see [. . .] the badgers and the deer [. . .] beautiful, absolutely gorgeous, we are so lucky.*
>
> *R5, f, site C, 2015*

> *I've seen deer literally walk 10, 15 yards in front of me.*
>
> *R5, m, site B, 2017*

Barriers to access and use of the woods before the interventions

Access to site A was less apparent than it used to be owing to recent residential development blocking former access points and hiding views of entry points into the woodlands:

> *There's a lot of new houses. There's only one wee path now, that sort of takes you over the back road.*
>
> *R1, f, site A, 2015*

> *You can't really get into it [. . .] The houses are all roundabout it [. . .] You used to go from [the park] just across the road, and that was you in [the woodland].*
>
> *R4, f, site A, 2015*

Several mentions of the quality of site A prior to the interventions noted that antisocial behaviour, including littering, fly tipping and drinking alcohol, were deterrents to use. One of the participants (a local councillor, although he was asked to participate in his personal capacity) had been invited to visit the site prior to the interventions because of concerns about activities going on there:

> *There was a real sense of, kind of, danger, almost, that you didn't know what was lurking round the corner, or in the bushes, and things like that [. . .] It didn't feel like the kind of place that people were particularly welcome in, to be honest [. . .] There was a pretty well established kind of den of, like, garden furniture, and all sorts of things, that had been put in the woodlands, and were protected with shopping trolleys, and all sorts of things [. . .] it was, basically, for gang fights, and under-age drinking, and all those kind of things, rather than pleasant woodland activities.*
>
> *R2, m, site A, 2017*

Site B was more accessible in terms of having a number of entrances that participants knew about from before the intervention. Deterrents identified before the intervention included the poor quality of paths on site:

> *At one time the path was just bogs [. . .] The mucky paths [. . .] it was almost impossible to get them [the children] from one place to another, without either you or them getting ankle deep.*
>
> *R1, m, site B, 2015*

At site C, antisocial behaviour, such as fly tipping, litter and fires, as well as the poor quality of the paths and vegetation (especially owing to the site's steep gradient) prior to the intervention all acted as deterrents to use:

> *It was a bit diabolical, the woods were dirty, one section was really made a dumping ground, and again I would probably say there were more gangs, the kids were lighting fires.*
>
> *R6, m, site C, 2015*

> *[B]roken glass, nettles, it was overgrown, it was just an eyesore. Yes, it was in a really bad state.*
>
> *R10, m, site C, 2017*

> *[T]he woodland was all rough, it was dense [. . .] you couldn't actually walk properly in the woodland [. . .] the kids [. . .] made dens in where they do their drinking and their drugs and everything else, so it wasn't a nice place to go to.*
>
> *R9, m, site C, 2017*

Awareness and experience of the interventions

In 2017, many of the focus group and interview participants across all the intervention sites said they visited the woodlands at least once per week and in this respect they were not typical of the wider community as revealed in the core survey data. Awareness and use of the social interventions was more varied. Individuals had learnt about the interventions through direct observation of the physical changes in the woodlands, social media, posters and community networks. Lack of time and lack of awareness were factors alluded to by respondents for non-participation.

The majority of site A participants were unaware of the interventions and in 2015 the site was still not known as a woodland available for local community use. For this reason, they had little to offer on their direct experience of the interventions:

> *My son jogs quite a lot, and he jogs for miles [. . .] so he jogs all roundabout, but I don't even think he knows about that [the woodland and their improvements].*
>
> *R4, f, site A, 2015*

When shown images of the paths and the upgraded entrance to the woodlands that the intervention in site A produced, participants in 2015 and 2017 were interested and some were positive about the images, but many had not noticed the changes:

> *I've never seen where that one [path] is [. . .] I didn't know they had changed it all. I'm definitely going out looking for that.*
>
> *R1, f, site A, 2015*

> *I've never seen it [the new woodland entrance] myself [. . .] The road's a wee bit better, but bet you it's still got potholes in it. You need your wellies going along that one.*
>
> *R3, f, site A, 2015*

> *I think it looks alright, it looks like somewhere that you could go for a walk now.*
>
> *R4, f, site A, 2015*

> *This [new entrance] is much more open, much more welcoming, they've given you an idea of where you're supposed to go. I know, from when I had gone before [. . .] you weren't really sure if there was an official route that you were supposed to go. But this is much more clear, I think, for people.*
>
> *R2, m, site A, 2017*

However, at least one 2017 participant was aware of the community engagement activities associated with the intervention:

> *The only reason I was aware of it as a woodland, was because of some of the early things, some of the early communications that came out from the Forestry Commission, about the projects that you had been doing.*
>
> *R2, m, site A, 2017*

Participants from sites B and C showed greater awareness in 2015 of the interventions and some had been involved in activities undertaken as part of the phase 2 community engagement events. Participants had learnt about the interventions through direct observation of the physical changes in the woodlands, social media, posters and community networks, and some people who had not previously visited were attracted by the community events:

> *I personally didn't [visit the woods before the changes]. It was a forestry-organised day that attracted me to the woodlands, where they had wood carving and stone carving and stuff, and that was the first time we had ever really noticed it. I knew it was there, but I wouldn't have gone walking on it myself previous to that, I didn't exactly know what it was [. . .] I think it was social media that I first saw something on through the [local community] development trust page, I think it was, and we went along for a nosey to see exactly what was happening, and they've held two or three events.*
>
> *R2, f, site B, 2015*

The people who turned up [. . .] there was definitely a couple of people that I would say probably would never appear in the wood, turning up in their flip-flops and pushing the pram, type thing, and they had a look about and they had fun, whether or not they would normally go.

R2, f, site B, 2015

Participants at site C in both 2015 and 2017 had engaged in a number of activities that they mentioned, including a photography workshop, a litter pick-up, bulb planting, a scavenger hunt and other family activities, which they also said had increased enjoyment and social interaction with family and neighbours. Participants also noted that people from further afield, beyond their community, had travelled to take part in the activities, suggesting that the reach of the interventions was wider than that captured by the core survey:

The whole family went down [for the scavenger hunt].

R6, m, site C, 2015

It was a positive change because it encouraged us to go into the woodland and we met different people and it's a different area to go to, so it's not the same place . . . It's handy, you don't need to take the car, no travelling really.

R10, m, site C, 2017

It's good because it's accessible now.

R7, f, site C, 2017

It's usable, it's owned, people will use it now.

R5, m, site C, 2017

It's more attractive to the eye, which makes you want to go in.

R4, f, site C, 2017

There was also a wish for community-based facilitation of activities to continue:

They were a great idea, but they should be done again now that the woodland's being used more. It's time for round two and get all those people that you didn't have before, get involved.

R4, f, site C, 2017

However, across all sites, concern was expressed in 2015 about lack of adequate consultation on the interventions that happened, and some cynicism about how much difference it would have made to what was undertaken:

I'm actually on the Tenants and Residents Association for [nearby community], and I've never heard of anything on that [FCS community engagement activities].

R4, f, site A, 2015

I think it's always nice to know about what's going on on your own doorstep, and too many things are done underhanded, so even though I wouldn't have objected to what's been done or it didn't affect me in any way at all, it still would have been nice to know.

R2, f, site B, 2015

There's never been any consultation or anything like leaflets or anything. Not that I'm aware of.

R5, f, site C, 2015

A girl came round the door when the Forestry Commission was just going to go into [the woods].

R4, m, site C, 2015

Would it have mattered if we had had a view?

R2, f, site C, 2015

Would they have listened?

R1 f, site C, 2015

Woodland behaviour and experience post intervention

Activities

The woods post intervention were used in a variety of ways, although for many this was not necessarily a behaviour change but a continuation of use. Site A was used by a participant already familiar with it but another, less familiar it, needed to find out where it was:

I've cycled through it, not knowing what it was.

R3, m, site A, 2017

After viewing photographs of the interventions, some participants in both 2015 and 2017 identified how they might use it in future:

I've got a son that's got autism [. . .] [walking] makes him do exercise that he doesn't want to do, but he'll go for a walk, you know [. . .] we do all different routes, we do different kinds of places. So that would be another place for us to go.

R4, f, site A, 2015

[I'd like] a ranger, that goes, right, I'd like to organise nature walks. So we're gonna do a nature walk once a week, or once a month.

R3, m, site A, 2017

Site B continued to be used by dog walkers from 2015 to 2017 but participants also talked about visiting with children, viewing wildlife and other activities:

I take my daughter now and we go up with the dog and it's great [. . .] I always take my camera, and I've started trying to get my daughter into photography as well, so I've been telling her to take her camera and just look for things that she thinks are interesting, just to take photographs.

R3, m, site B, 2015

My kids like the little kind of wooden stepping things that [the Forestry Commission] put in over the summer, they absolutely love that [. . .] steps and posts and balance beams [. . .] My kids, when they came up and found them, they spent an hour just following the same wee bit round and round.

R2, f, site B, 2015

I think it's great because again, it's dual purpose, it's got an interest for the children, but it's also exercise, and a lot of kids will play at it and not realise that they're actually exercising because it's just play, but at the same time they're getting some great exercise out of it.

R3, m, site B, 2015

Now that I've retired I tend to go there at least three or four times a week. I'm usually walking my dog. And I usually have binoculars with me or my camera with me because I'm a keen bird watcher and wildlife watcher.

R5, m, site B, 2017

However, there were also comments on the vandalism and damage by 2017, 23 months post intervention, that meant some participants had stopped using the site so much:

> *The problem with glass and also the picnic benches being damaged, we don't take the kids down there very often. We used to go up for picnics all the time [. . .] my husband runs there every week, and I go for a walk from time to time. But we don't take the kids nearly as often as we did.*
>
> *R6, f, site B, 2017*

The path improvements at site C were particularly commented on in both 2015 and 2017 as making a big difference to woodland access and use:

> *Now you can have a nice walk.*
>
> *R1, f, site C, 2015*

> *It's easier access. You don't need your wellies as much.*
>
> *R5, f, site C, 2015*

> *The biggest change is the main path, it's [now] something you could use when it's raining with just normal footwear. You didn't have to go in there wearing wellies, and they thinned a lot of the woodland out so you could actually see more in the woods, opened the woods up. It just made it 10 times better than it was [. . .] I could take my daughter, because she was then starting to walk so we wanted to go [on] enough walks to get her exercise, get the fresh air, so that opened up that and we were using it daily after all the path was implemented.*
>
> *R9, m, site C, 2017*

> *I might get off at the bus stop a bit earlier, walk through the woodland path [. . .] rather than walking on the pavement, away from the traffic, that's really using it as a shortcut, that does improve life [. . .] It's good for exercise, there's a number of paths that you can use. It's uphill, so you're burning up more energy as you're going up and down.*
>
> *R5, m, site C, 2017*

As with site B, activities mentioned post intervention at site C included dog walking, photography and use by children as well as nature conservation activities:

> *We've done an RSPB [Royal Society for the Protection of Birds] Award, it was called the Wildlife Action Awards, we've done them in the woodlands. We've also done a John Muir Award using our local woodlands as well. [. . .] The rangers were a fountain of knowledge from the Forestry Commission and they had some engaging programmes that would spark the interest of my daughter and that sort of rubbed on me a little bit because I was obviously trying to help my daughter, but by helping her it was actually helping me with my mental situation, my mental health.*
>
> *R9, m, site C, 2017*

Peace and calm

A common theme across all three sites from participants who visited the woodlands was the peace and calm they felt when there. This had not changed over time and was reflected in the focus groups in both 2015 and 2017:

> *It's peaceful [. . .] it used to be bad years ago but now it's quite peaceful. You just cut through and nobody bothers you.*
>
> *R1, f, site A, 2015*

It's easy enough to access [the woods]. My son does not like going past the sports centre because it's too busy, too noisy, that's a barrier for him with his condition [Asperger syndrome] [. . .] he likes the peace, he does not like noise at all, so he finds it calming, which is why we quite often have started going there more so than usual.

R2, f, site B, 2015

I take the car to the top and then me and my grandson and the dog go for a wee walk and it's just calming if you're like having a stressful day [. . .] and you're listening to the birds and the view and you just think, there's so much rubbish going on in the world and you just think, we're here, it's quiet.

R5, f, site C, 2015

I just go into a wee dwam [dream] when I'm walking through it.

R4, m, site B, 2017

Basically calms you down [. . .] you know, the stress and everything.

R2, m, site C, 2017

Connecting to nature

In line with the general comments on natural environments in the neighbourhood, participants at sites B and C described their appreciation of nature when using the woods post intervention:

[I enjoy] just being close to nature, I think.

R3, f, site C, 2015

The view is absolutely gorgeous [. . .] You couldn't put a price on that. I like the freedom of just being able to just walk and just enjoy the nature that's there.

R5, f, site C, 2015

I'm a keen bird watcher and wildlife watcher [. . .] I was looking at the deer only yesterday, three roe deer [. . .] I enjoy that [. . .] The wildlife side of that, that pond [. . .] I look at that as a beautiful area. Alright, it's got a little bit of litter in it but it's nice in the sense it's attracting all sorts. I mean I've seen hundreds of frogs. It's brilliant to see that. The birdlife there is stunning [. . .] And that's the beauty of the quietness actually.

R5, m, site B, 2017

Sociability

Opportunities for social engagement in the post-intervention woodlands were occasionally mentioned by participants, usually in the context of regular users, such as dog walkers and walkers or runners; at site C by 2017 there was specific mention of community cohesion:

There were lots of great activities the Forestry Commission ran [. . .] We spoke to some of the neighbours who had kids as well, they went along.

R6, m, site C, 2015

They [dog walkers] go at specific times, so you tend to meet the same people. So yeah, you do meet people.

R5, m, site B, 2017

When I'm running I usually get nods from other runners, people like that [. . .] When I've got the dog [. . .] people tend to talk to you more when you've got a dog actually strangely enough.

R6, m, site B, 2017

It's a nice place to meet.

R4, f, site C, 2017

The family day [. . .] I definitely think that brought the community together [. . .] there was a sort of ripple effect of the area feeling that bit nicer, it's now got a nice woodland, it's got a nice walk.

R9, m, site C, 2017

Barriers to use of the woods after the interventions

Participants at sites B and C identified a number of barriers to use after the interventions, particularly by 2017, once the activities and maintenance associated with the interventions had ceased to be undertaken by FCS in 2015. The main themes of complaint were about vandalism and uncontrolled dogs and dog faeces. Issues of safety were also raised and concerns about the lack of ongoing maintenance, which restricted some people's use of the woods, but there were differences of opinion on whether or not all of these things had got worse again.

Vandalism

Years ago, I probably done it [vandalism] myself!

R1, f, site A, 2015

There was three beautiful sculptures put up in February and by [. . .] March or something, one of them had been set on fire [. . .] A friend of mine was on some kind of [community] committee and they approached the forestry to take the remaining two away for their own safety [. . .] They were beautiful sculptures, and the kids loved going through the trees and the path until they found them, and finding things like that was a joy [. . .] but to have the yobs go up at night and think they're funny and set it on fire wasn't very nice either, so unfortunately, yes, it [vandalism] does happen.

R2, f, site B, 2015

If it's my day for picking the bairn [child] up, coming back that way [the woodlands], but to me it's no really safe the now because either they're going to get stung or they're going to fall on dogs' poo. So, I've been using the car the now and it's a shame because it's a lovely walk.

R5, f, site C, 2015

I used to walk this in 2013 and I thought it was nice. It was nice to see the introduction of new stuff as well, the benches and stuff like that. And I think one of the things that really angered me was the burning of them.

R5, m, site B, 2017

There's just a million poo bags from pretty much the entrance of it [the woods] to near where people are parking their cars.

R1, f, site B, 2017

The last time I went there was a dog walker who had seven dogs. None of them on a lead and one of them jumped up on me. One of them got very aggressive.

R6, f, site B, 2017

[B]efore the Forestry Commission thinned it all down, you used to get a lot of yobs in there at the weekends, and they used to light fires, and all sorts of rubbish [. . .] but that seems to have sort of vanished at the moment.

R1, m, site C, 2017

Feelings about safety

Site A participants talked about safety in general but the majority could comment on the woodland site only indirectly, or from when they were much younger, as they had not visited it themselves. There were sometimes contradictory views on whether or not the woods were safe and people mentioned a fear of dense trees and forests, without openness and views, and the need to cut things back to make places more open and to add lighting:

> *[The woodland's] familiar, and it's just something that's always been there when we were brought up, and you do feel safe.*
>
> *R3, f, site A, 2015*

> *It was always a safe place to play outside. Nowadays, weans don't actually play outside, do they, unless it's an adult standing with them [. . .] Although they're [local woodlands] all free, but better lighting would maybe encourage you to walk about them more.*
>
> *R1, f, site A, 2015*

Lack of continuing maintenance limiting use of woodlands

This was mentioned in 2015 and, particularly, in 2017, by which time maintenance had not been undertaken by FCS for at least 20 months:

> *The off-road bikes that go in there [. . .] churning up the path, churning up the grass [. . .] You've got the kids drinking on the Friday nights away up the back, and there's no maintenance on the actual path, because it used to be about 5 metres wide, now they're less than a metre in certain places because they're not getting trimmed. So if you've got a buggy and you're trying to fight missing the dog mess and then you're getting caught up in the weeds or the overgrown grass [. . .] I've had to stop using the woodlands now for the past 6 months.*
>
> *R6, m, site C, 2015*

> *The problem with glass and also the picnic benches being damaged, we don't take the kids down there very often.*
>
> *R3, f, site B, 2017*

> *I got to a point where even I found it difficult walking with the dog on the pathways. It was overgrown.*
>
> *R5, m, site B, 2017*

> *That work they put in just hasn't been maintained.*
>
> *R4, f, site C, 2017*

> *Paths are starting to deteriorate.*
>
> *R5, m, site C, 2017*

> *It's too dirty to walk in those woods ever since the council took it back over, so I've got used to [another] wood.*
>
> *R9, m, site C, 2017*

Desire for more features

As well as concerns about poor maintenance, participants also identified a desire for more features in the woodlands. Items mentioned included the provision of more seating, fireproof benches, entrance gates that prevented off-road bikes from accessing the woods, additional picnic tables, further tree felling to provide attractive vistas, bird boxes, more bins and play equipment for children. In the case of site A,

comments were largely based on looking at photographs of the site rather than direct experience, with a desire for space and good visibility around trees to keep things open:

> *[So as] you can look about and see there's nobody behind a tree [. . .] It could be a wee bit better if they put a couple of lights in it, to make it that bit safer.*
>
> *R1, f, site A, 2015*

> *I think the thing that's missing most is signage [. . .] they have all these wonderful paths, but they never have the signage saying where it's going to take you or anything like that.*
>
> *R3, m, site B, 2015*

> *I think they could do with an extra odd bench, picnic bench, at different parts, because there's one area with two tables, they could maybe do with another one or two scattered about, because if you've gone up with a picnic and the tables are busy, then the kids are like, where are we going to eat lunch.*
>
> *R2, f, site B, 2015*

> *If they could put more seating in, it would be great because I've got limited mobility, so there is times when you're walking and you just need to sit down, and I'm not talking about proper benches, even a log or something like that, that you could sit down on, would be superb.*
>
> *R3, m, site B, 2015*

> *Some kind of stone stand you could put them [barbecues] on.*
>
> *R6, f, site B, 2017*

At site C there was also mention of the need for more seating, especially for those with limited stamina or mobility, as in site B, as well as dog bins and barriers to keep motorbikes out (2015). There was also mention of a need for more things for children and better information about activities.

Wider neighbourhood issues

The final theme covered issues about whether or not there were aspects of the wider neighbourhood context, positive or negative, that might have had a bearing on people's well-being and quality of life during the study period.

Participants at site A considered that theirs was a good neighbourhood in general, both for those who had lived there all their lives and for those who had recently moved there. However, the woodland site for the intervention was marred in terms of access by recent (prior to the study) housebuilding:

> *Like a community, so people know people.*
>
> *R4, f, site A, 2015*

> *It's a good neighbourhood for me. Because I've stayed in areas that weren't as good.*
>
> *R2, f, site A, 2015*

> *They built all they houses, they just built them alone, and they never consulted, and they sort of barricaded it off so you couldn't get in [to the woodlands].*
>
> *R4, f, site A, 2015*

At site B, there had been local council-funded work on footpaths adjacent to the woodlands, linking them to the sports centre and other parts of the community, in the summer of 2015. A parkrun (parkrun Limited, Twickenham, UK) running group had been set up after the study was complete and attracted a good number of people each Saturday. Although there was appreciation for recent building developments,

participants had mixed views on the sense of local community, after a period of regeneration following the decline of a retail centre built 20 years previously:

> *One of the tragedies was that this [the town hall where the focus group was held] wasn't built 20 years ago.*
>
> *R1, m, site B, 2015*

> *I think when [the community] was smaller there was a stronger sense of community.*
>
> *R2, f, site B, 2015*

> *Apart from the community council and youth group, the likes of the development trust, other than that, I don't think there is a great deal [of a sense of community].*
>
> *R3, m, site B, 2015*

> *I have lived in about eight different houses in [the community], family circumstances change, bigger houses needed, that kind of thing.*
>
> *R2, f, site B, 2015*

At site B in 2017 there was also mention of aeroplane noise from the flight path overhead:

> *Sometimes my house shakes [. . .] You hear a noise when it's a big plane [. . .] you definitely notice an increase in noise.*
>
> *R6, m, site B, 2017*

> *I think you just get used to it. We are directly on the flight path and probably in the summer you're more aware of it.*
>
> *R1, f, site B, 2017*

At site C, comments were made about the desire for more consultation over developments, including the WIAT interventions and new housing developments:

> *They should stop building more houses on the top, because the skyline is kind of spoiled. But, it is, it's beautiful, I wouldn't move anywhere else.*
>
> *R5, f, site C, 2015*

Summary

In summary, the focus group and interview results suggest that the positive changes in intervention sites noted by community-led site audits were largely appreciated by community members, although these were often participants who already visited the woods regularly. This contrasts with the very low awareness (2% of the sample) of the phase 2 interventions in the core survey. Although many of the focus group and interview participants had engaged in intervention activities, this did not reflect the experience of the wider community as revealed in the core survey, which indicated that the social interventions attracted only a very small proportion of the local population. Some focus group participants said that phase 2 attracted people from outside the local community, suggesting that the intervention had a reach beyond our core survey population.

Positive responses to the intervention included walking and other activities within the woodlands, appreciation of wildlife and nature (including the value of engaging children in nature) and enjoyment of peace and quiet, with mention of associated feelings of well-being. There was also some evidence of positive social engagement and community benefits. However, in terms of major behaviour change, there was less evidence. A small number of participants had visited the woodlands for the first time as a result of

the interventions but most were either unaffected by the interventions (at site A) or were already site users (at sites B and C). There was evidence of increased site use and enjoyment by participants from sites B and C post intervention, although this had declined by 2017 owing to lack of site maintenance. However, at least some of the participants indicated that they may have transferred their activities to other local natural environments from the intervention woodlands.

Negative comments on the interventions largely focused on vandalism, litter and dog faeces, overgrown vegetation and deterioration of footpaths that reflected a lack of maintenance after the interventions were completed in 2015. Requests for new or different interventions in the woodlands related to enhancing usability, especially for those with mobility impairment, for example by adding benches, providing facilities that resist vandalism, enhancing safety through lighting and vegetation management, and continuing facilitated community engagement for children and for adults.

Overall, there is considerable consistency between the comments made by community site auditors (see *Environmental audit data*) and the focus groups and interviews, particularly over concerns in relation to barriers and deterrents, such as litter, vandalism and dog fouling, and the attraction of good paths and other facilities and views of nature and wildlife.

Chapter 5 Economic evaluation

Abstract of the economic evaluation

Objectives

To evaluate the cost-effectiveness of the WIAT interventions in terms of the health outcomes and undertake the overall CCA for the primary and secondary outcomes.

Methods

The cost of the WIAT interventions was assessed using a top-down approach based on resource use. The QALY benefit from the WIAT programme based on the adjusted regression models was combined with cost to give an indicative cost per QALY in a CUA that included an assessment of uncertainty. All analyses were undertaken from a societal perspective for the 2-year period. A CCA presented the cost of the interventions together with the primary and secondary outcomes in a balance sheet format.

Results

The total cost of the interventions was £241,667 across the estimated eligible population ($n = 20,472$). The average cost for the physical intervention in wave 2 was £7.68 (95% CI £7.67 to £7.69) and £11.80 (95% CI £11.79 to £11.82) for both physical and social interventions in wave 3. There was no evidence of a statistically significant association between the interventions and HRQoL. An illustrative CUA in panel A reveals an incremental ICER of £935 (95% CI £399 per QALY to dominated) in wave 2 for the physical intervention (thus higher cost and lower QALY than in the control) and an ICER of £662 (95% CI £206 per QALY to dominated) in wave 3 for both social and physical interventions. The cost per QALY in panel B is £361 (95% CI £160 per QALY to dominated) for wave 2 after the physical intervention and £165 (95% CI £71 per QALY to dominated) for wave 3 after both social and physical interventions. Overall, the CCA suggests significant effects for the secondary outcomes of moderate physical activities, walking activities, connectedness to nature and social cohesion in panel A, and moderate activity and overall PA for panel B.

Conclusion

The interventions were not associated with any statistically significant improvements in health, hence there is no basis for demonstrating cost-effectiveness. However, the cost per individual in the eligible population is highly significant but low in magnitude. The CUA suggests that even small benefits in HRQoL, if found perhaps after a longer-term evaluation, have the potential to be relatively cost-effective at willingness to pay (WTP) of £20,000. The CCA also shows that the WIAT interventions have the potential to provide other benefits, if causally attributed to the interventions and considered of sufficient magnitude, at low cost.

Introduction

In this chapter, the potential cost-effectiveness of the WIAT interventions is considered. *Costs of interventions* presents the costing of the physical and social interventions as described in *The Woods In and Around Towns interventions: environmental and social interventions* and *Economic evaluation*. In *Health-related quality of life*, consideration is given to the impact of the WIAT interventions on HRQoL as measured by the EQ-5D instrument, including the sorts of adjusted analyses presented for other secondary outcomes. *Cost–consequences analysis* presents the cost–consequences analysis using a balance sheet that shows all of the key end points alongside the summary of the costs. *Cost–utility analysis* explores the potential cost per QALY of the interventions.

Costs of interventions

A record of the external costs of both WIAT interventions, physical and social, as described in *Chapter 2*, and the time to manage and administer activities, was obtained in close liaison with FCS. *Table 27* gives a summary of the costs involved for each intervention site and phase of intervention.

These costs of the WIAT programme apply across the populations affected by the WIAT intervention. The average cost per individual was calculated as the total cost divided by the eligible population ($n = 20,472$) of the WIAT programme for whom the interventions might be considered to have an effect. This resulted in the average cost of £7.68 for the physical intervention in wave 2 and £11.80 for both physical and social interventions in wave 3 for the population covered by the interventions.

Health-related quality of life

Unadjusted results

The observed mean EQ-5D HRQoL utilities in the intervention and control sites for all the waves are shown in *Table 28* for panel A and panel B data sets.

These results are also presented in graphical form in *Figure 21* for panel A and *Figure 22* for panel B.

The results for panel A show an approximate balance across control and intervention sites at wave 1. After the physical intervention at wave 2, the results have not greatly changed. At wave 3, after the social intervention, whereas the control groups have a EQ-5D HRQoL utility comparable to baseline, there was a

TABLE 27 Summary of costs of interventions

		Cost (£)		
Intervention site	Description of costs	Physical intervention	Social intervention	Total
A	Internal FCS time	12,060	3922	
	External	20,652	16,126	
	Total	32,712	20,048	52,760
B	Internal FCS time	15,150	32,024	
	External	49,087	16,066	
	Total	64,237	48,090	112,327
C	Internal FCS time	14,936	12,052	
	External	45,374	4218	
	Total	60,310	16,270	76,580
All sites		157,259	84,408	241,667

TABLE 28 Observed EQ-5D HRQoL utilities

	Panel			
	A		B	
Wave	Intervention	Control	Intervention	Control
1	0.856	0.863	0.784	0.837
2	0.867	0.866	0.811	0.799
3	0.815	0.850	0.746	0.801

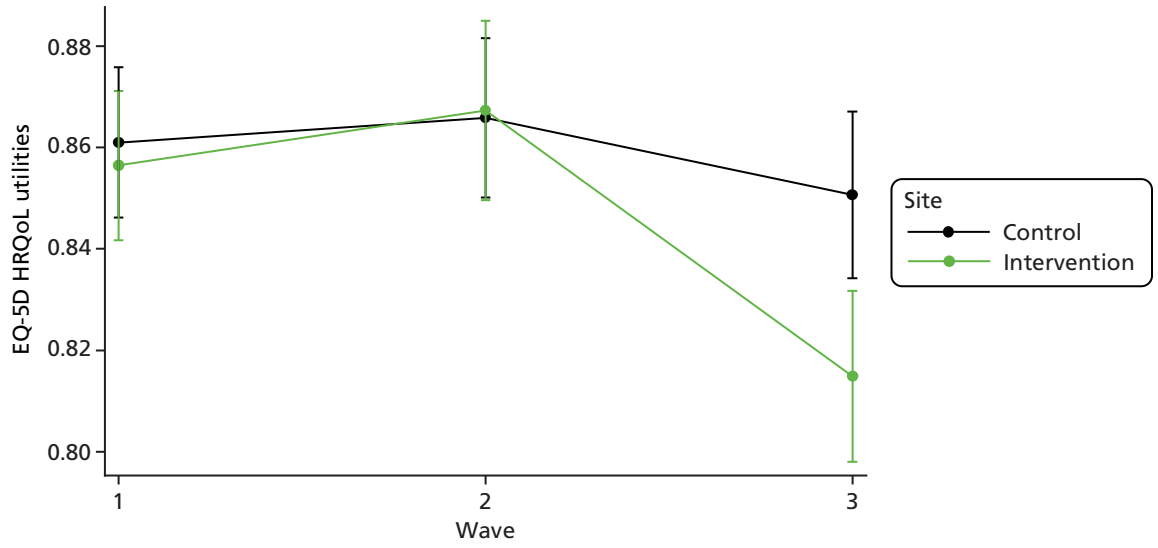

FIGURE 21 Unadjusted predicted means of EQ-5D HRQoL utilities for panel A.

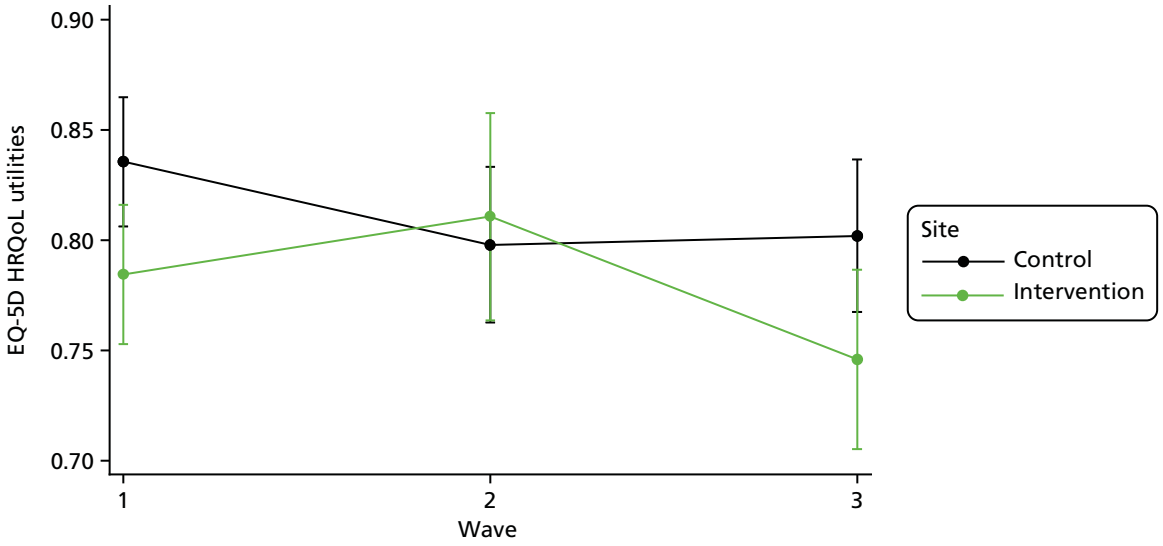

FIGURE 22 Unadjusted predicted means of EQ-5D HRQoL utilities for panel B.

strong fall in EQ-5D HRQoL utility in the intervention group that was both significantly different from the baseline measure and significantly different from the wave 3 utility in the control sites.

The results for panel B show a significant imbalance at baseline, with worse HRQoL in the intervention group. By wave 2, the control sites have lower EQ-5D HRQoL utility than baseline, whereas EQ-5D HRQoL utility at the intervention sites has increased, with the net effect that the difference between the intervention and control sites is negligible. In wave 3 there is no apparent change in EQ-5D HRQoL utility for the control sites, but EQ-5D HRQoL utility for the intervention sites has fallen.

The overall effect of the WIAT interventions on HRQoL was estimated using an ITT approach as described in *Core survey of community residents*. This was captured by the interaction term of type of site (intervention and control sites; control sites as reference group) and wave of survey (waves 1, 2 and 3; baseline wave 1 as reference group). This has the advantage of adjusting for any imbalances in the EQ-5D HRQoL utilities at baseline. *Table 29* presents the unadjusted results of panel A and panel B samples.

TABLE 29 Unadjusted panel A and panel B analysis

EQ-5D HRQoL utility	Coefficient	SE	*p*-value	95% CI
Unadjusted panel A				
Intervention	–0.005	0.011	0.669	–0.025 to 0.016
Wave 2	0.005	0.011	0.659	–0.017 to 0.026
Wave 3	–0.010	0.011	0.359	–0.032 to 0.012
Type of site × *wave*				
Intervention × wave 2	0.006	0.016	0.710	–0.026 to 0.038
Intervention × wave 3	–0.031	0.016	0.052	–0.063 to 0.000
Constant	0.947	0.021	0.000	0.906 to 0.988
Unadjusted panel B				
Intervention	–0.051	0.022	0.020	–0.094 to –0.008
Wave 2	–0.038	0.023	0.107	–0.084 to 0.008
Wave 3	–0.034	0.023	0.145	–0.079 to 0.012
Type of site × *wave*				
Intervention × wave 2	0.064	0.037	0.086	–0.009 to 0.137
Intervention × wave 3	–0.005	0.035	0.889	–0.074 to 0.064
Constant	0.836	0.015	0.000	0.806 to 0.865

The overall results for both samples mirror the observed results but the overall effects are less pronounced after adjustment for baseline imbalances. There is a positive effect of the physical intervention in both panel A and panel B analyses and a negative effect of the physical and social intervention combined at wave 3. However, none of these results are significant and they are unadjusted for other imbalances between the intervention and control sites.

Adjusted results

In addition to adjusting for imbalances in EQ-5D HRQoL utilities at baseline, the model can also be adjusted for age, gender, social class, perceived income coping, distance bands to local woodlands, working status, education, car ownership, life events, smoking, disability and differences in site pairs (intervention and control sites). *Table 30* presents the results of the effect of the WIAT interventions on HRQoL after adjustment and, as before, the best estimate of WIAT effect is from the intervention interactions with the wave of the data from panels A and B.

The results of the adjusted analysis show very similar results to the unadjusted analysis for panel A. As for panel B, the intervention effect for the physical and social intervention combined at wave 3 shows a reversal from very slightly negative to very slightly positive. However, all these results need to be interpreted in context: none of the interaction terms were statistically significant, so there remains substantial uncertainty as to the true effect of the WIAT interventions on HRQoL.

TABLE 30 Adjusted panel A and panel B analysis

EQ-5D HRQoL utility	Coefficient	SE	*p*-value	95% CI
Adjusted panel A sample				
Intervention	0.003	0.008	0.683	–0.013 to 0.020
Wave 2	–0.004	0.008	0.620	–0.020 to 0.012
Wave 3	0.000	0.008	0.980	–0.017 to 0.016
Type site × wave				
Intervention × wave 2	0.017	0.012	0.158	–0.007 to 0.040
Intervention × wave 3	–0.007	0.012	0.546	–0.030 to 0.016
Constant	0.900	0.023	0.000	0.854 to 0.945
Adjusted panel B sample				
Intervention	–0.026	0.019	0.164	–0.062 to 0.011
Wave 2	–0.026	0.017	0.137	–0.060 to 0.008
Wave 3	–0.004	0.017	0.804	–0.038 to 0.030
Type site × wave				
Intervention × wave 2	0.044	0.028	0.110	–0.010 to 0.098
Intervention × wave 3	0.009	0.026	0.744	–0.043 to 0.060
Constant	0.876	0.058	0.000	0.762 to 0.990

Cost–consequences analysis

Tables in *Appendix 8* (see *Tables 53–57*) present the full results of a CCA for both panel A and B samples. The per population cost of the intervention is compared with per person effects, taken from the adjusted ITT models for the primary outcome of PSS and the array of secondary outcomes, including the EQ-5D HRQoL analysis reported in *Health-related quality of life*.

Overall, the CCA summarises the multiple outcomes of the WIAT programme and emphasises that the only significant effects were for the secondary outcomes of moderate physical activities, walking activities, connectedness to nature and social cohesion in panel A and moderate activity and overall PA in panel B. The cost per individual in the population is highly significant but low in magnitude, which means that WIAT interventions have the potential to offer value if the effects indicated above can be causally attributed to the intervention and are considered of sufficient magnitude.

Cost–utility analysis

One of the problems of CCA is that there is no inherent guidance given as to the value of the outcomes in relation to their cost. For this reason, in the second stage of the economic evaluation, the QALY benefit from the WIAT programme based on the adjusted ITT models was combined with cost to give an indicative cost per QALY in a formal CUA that included an assessment of uncertainty.

The cost input required in the CUA was the incremental expected cost of the physical intervention and both the physical and social interventions per individual in the population, as estimated in *Abstract of the economic evaluation*. The QALYs were calculated from the adjusted ITT HRQoL results reported in *Table 30*

using the area under the curve approach, which assumes linear interpolation in the change in HRQoL between the waves.[91,92] These results are coefficients of the interaction term (type of site and wave), which represent the incremental HRQoL utilities between the intervention and control groups in wave 2 for the physical intervention and wave 3 for both physical and social interventions. Thus, QALYs have been computed as a product of the time difference and the average of the two measurements of HRQoL utilities between waves. QALYs for wave 2 after physical intervention resulted from multiplying the average of the incremental HRQoL utilities from baseline to wave 2 by 1 year, which is the time between wave 1 (baseline) and wave 2, and QALYs for wave 3 after both physical and social interventions resulted from multiplying the average of the incremental HRQoL utilities from baseline to wave 2, plus the average of the incremental HRQoL utilities from wave 2 to wave 3, by 2 years, which is the time between wave 1 and wave 3. The baseline HRQoL utilities for the intervention and control groups are assumed to be the same after adjustment.

To account for the impact of time on costs and EQ-5D HRQoL utilities that happened, at different times, a discounting rate of 3.5% was used as per NICE guidelines.[78,82,93] However, we present the CUA over the time frame of the WIAT study only and so the impact of discounting in this analysis was inconsequential.

Table 31 presents the CUA results of the WIAT interventions in waves 2 and 3 for panels A and B.

Incremental cost-effectiveness ratios

When the results of the simulations for the incremental expected costs and QALYs are combined to give an overall ICER, panel A shows mostly positive costs and QALYs for physical intervention in waves 2 and 3 for both physical and social interventions, as presented in *Figures 23* and *24*.

Based on the accepted WTP threshold of £20,000[82] – the threshold for the amount that society is willing to sacrifice for each QALY gained – the point estimate suggests that the physical intervention is value for money with a net monetary benefit of £157, although the 95% uncertainty interval is wide (–£69 to £377) and includes zero, indicating a lack of statistical significance. A similar trend is shown when both the physical and social interventions are given in wave 3, as shown in *Figure 24*. At a WTP of £20,000 per QALY, the net monetary benefit becomes £345 with a wide 95% uncertainty interval (–£441 to £1138). Uncertainty was considerable around QALYs in both waves 2 and 3 as evidenced by the wide CIs shown in *Table 31* and the scatterplots of *Figures 23* and *24*.

TABLE 31 Cost–utility analysis of the WIAT interventions

ICER	Wave 2	95% CI		Wave 3	95% CI	
Panel A						
Incremental costs (£)	7.68	7.67	7.69	11.80	11.79	11.82
Incremental QALYs	0.008	–0.003	0.019	0.018	–0.021	0.057
Cost per QALY (£)	935.00	dom	399.00	662.00	dom	203.00
Panel B						
Incremental costs (£)	7.68	7.67	7.69	11.80	11.79	11.82
Incremental QALYs	0.021	–0.004	0.048	0.071	–0.018	0.167
Cost per QALY (£)	361.00	dom	160.00	161.00	dom	71.00

dom, dominated with higher costs and lower QALYs than control.
Note
The model estimation was based on more than three decimal places.

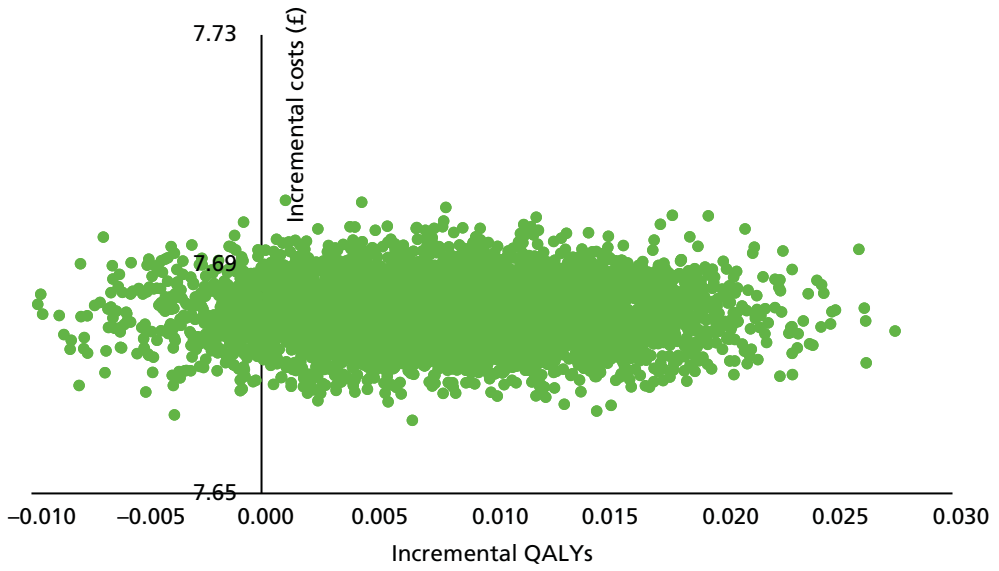

FIGURE 23 Cost-effectiveness plane for the physical intervention: panel A.

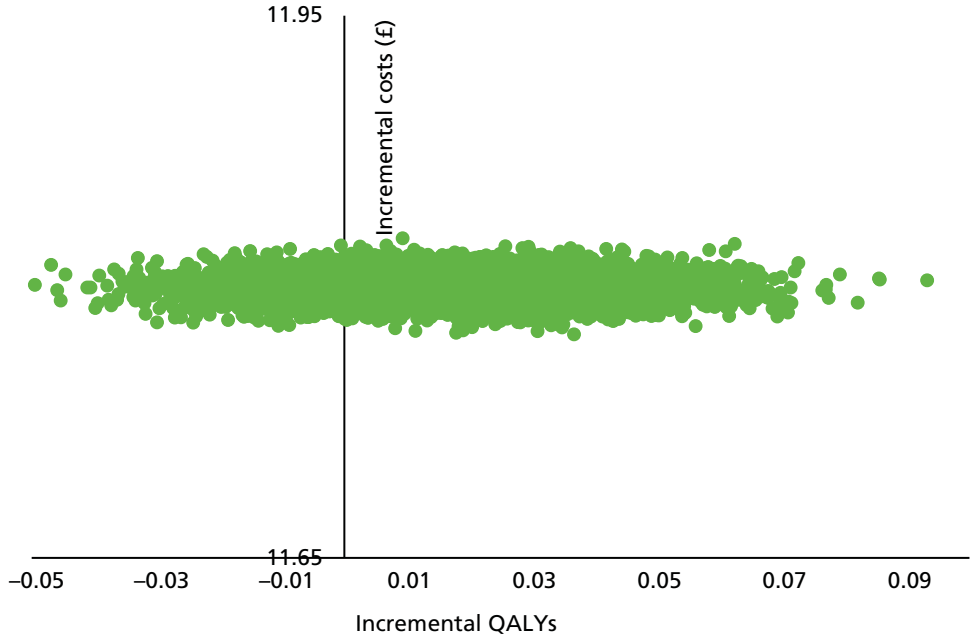

FIGURE 24 Cost-effectiveness plane for the physical and social interventions: panel A.

The results for panel B reveal that the majority of the simulated incremental costs and QALYs are positive in wave 2 for the physical intervention and in wave 3 for both physical and social interventions, as presented in *Figures 25* and *26*. This results in positive ICERs in both waves.

Based on the WTP threshold of £20,000 per QALY gained, the point estimate suggests that the physical intervention in wave 2 was cost-effective with the net monetary benefit of £417 (95% CI –£86 to £954). Similarly, the point estimate suggests that the physical and social interventions in wave 3 could also be cost-effective with the net monetary benefit of £1418 (95% CI –£368 to £3322) at a WTP of £20,000. However, none of these results is statistically significant with much uncertainty around the QALY estimates, as depicted in *Table 31* and *Figures 25* and *26*.

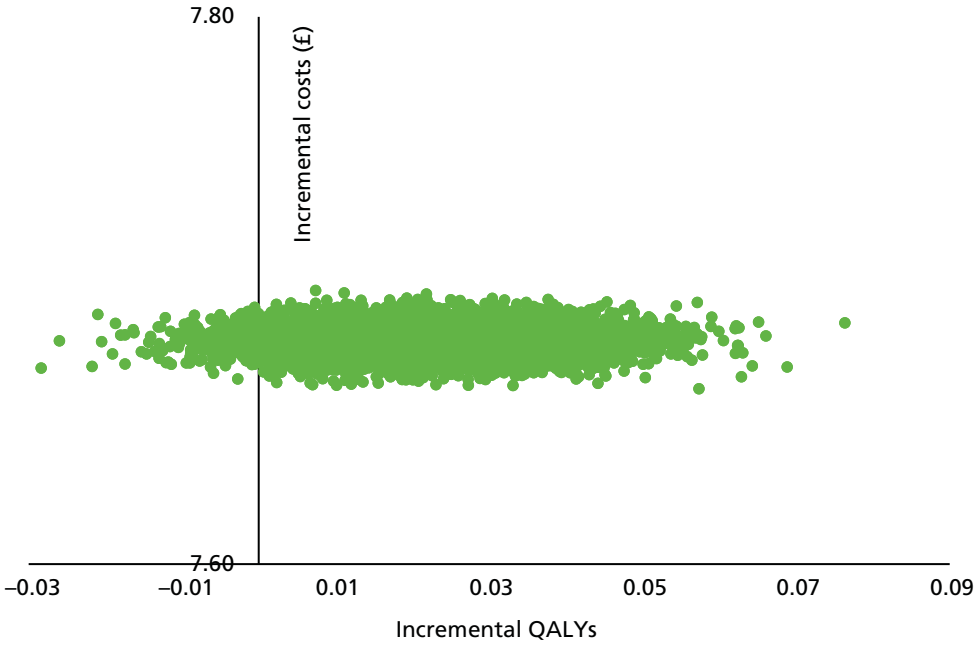

FIGURE 25 Cost-effectiveness plane for the physical intervention: panel B.

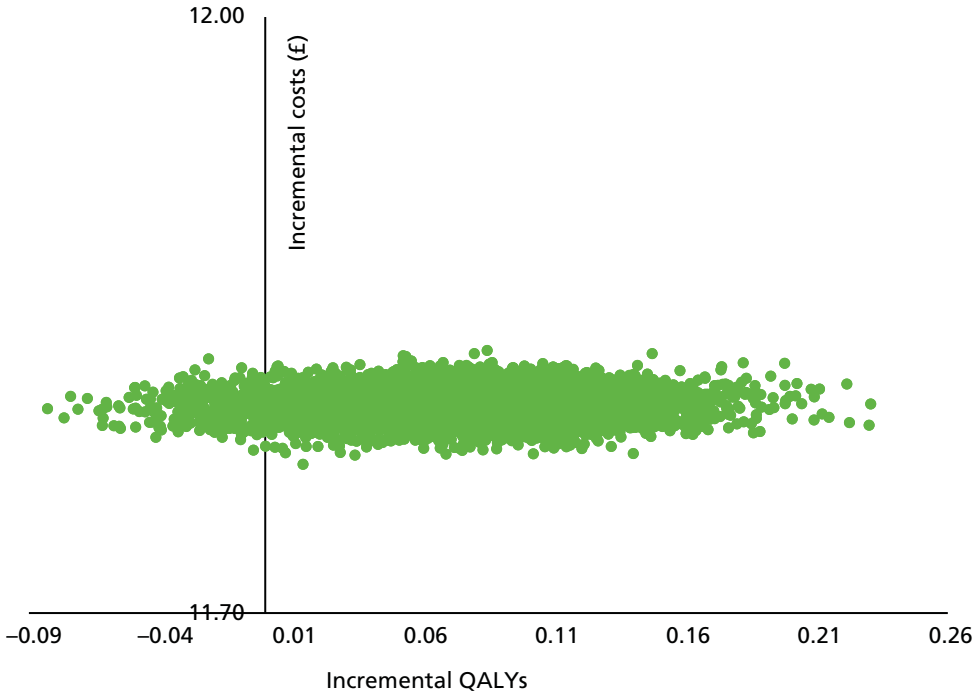

FIGURE 26 Cost-effectiveness plane for the physical and social interventions: panel B.

Chapter 6 Discussion

In this chapter, we discuss the principal findings of the study in relation to our initial research questions, as set out in *Research aims and objectives*. First, we consider mental health, particularly as indicated by perceived stress levels. We then discuss secondary outcomes, proximal and distal, including other health outcomes and other behaviours or effects that might be pathways to both mental well-being and stress outcomes, as indicated in our logic model (see *Figure 1*). The discussion of findings is based on results from the core survey data, considered in the light of the other analyses, including the site audits and qualitative data, in this mixed-methods study.

We then consider the implications of the findings, reflect on the nature and effectiveness of public involvement in the work and consider the challenges and limitations of the study. Last, we outline the principal contributions that the study has made.

Principal findings

The impact of the Woods In and Around Towns programme of interventions on mental health in the community

In relation to perceived stress levels (PSS), our main outcome measure, the intervention was associated with an increase in stress levels over time, whereas the control group showed a marginal decline in stress over time. The difference in PSS between the intervention and the control was significant for both cross-sectional and cohort panels by the wave 3 survey (post physical and social interventions). This finding was the opposite of what was predicted in our logic model based on previous research. Measures of mental well-being (SWEMWBS) showed a similar pattern, with a negative effect on well-being associated with the intervention. Our data offer no definitive explanation for this pattern of increasingly poor mental health associated with the intervention sites, but the analyses show that participants who visited nature did not display the same pattern. Qualitative findings suggest that certain other factors may have contributed to changes in mental health over time. For example, in intervention site B, an increase in disturbance from aircraft noise – a recognised stressor – and the difficulties associated with housing churn owing to urban renewal, may have contributed to increases in stress. Although the community audits indicated that the interventions noticeably improved the quality of the physical environment, the focus group and interview findings suggest that some concerns remained about using the woodland sites, especially after FCS maintenance ceased, although these were not so marked in 2015, the year of the wave 3 survey, as in 2017.

Health-related quality of life (measured using EQ-5D) was also considered using the same adjusted data sets as for stress levels. In this case, we found no evidence of a statistically significant association between the intervention and HRQoL.

The main finding relating to the above is that the intervention was associated with an increase in perceived stress and a decrease in mental well-being. Any beneficial effect from the WIAT interventions, as evidenced by the woodland audits and qualitative data, was not sufficient to produce beneficial effects on community-level mental health. Evidence on participants' engagement with the intervention woodlands and other natural environments, discussed in *Perceived stress and mental well-being outcomes associated with levels of engagement with woodlands or natural environments after implementation of the Woods In and Around Towns intervention*, suggests that the pattern of stress and mental well-being levels may reflect influences external to the intervention programme. In communities classified as areas of high multiple deprivation in accordance with the SIMD, there may well be other, area-level factors not captured by this study that have contributed to mental health outcomes in the study communities.

Perceived stress and mental well-being outcomes associated with levels of engagement with woodlands or natural environments after implementation of the Woods In and Around Towns intervention

In both panels, the increase in perceived stress and the decrease in mental well-being over time associated with the intervention was considerably greater for individuals who had not made nature visits (i.e. to woodlands and other nearby green spaces) in the previous year than for those who had made nature visits. In the panel B longitudinal cohort we did not find a significant increase in stress levels in the intervention sites for those who had made nature visits, whereas there was a highly significant increase in stress for those who had not visited nature. A similar pattern for mental well-being showed, in panel A, a significant increase in such well-being for those who visited nature, a significant decline for those who did not and a pattern for panel B mirroring that for perceived stress. This suggests that nature visits may have some stress buffering effects in this population, as other research has found.[94,95] It is also possible, however, that greater mental well-being is necessary as a precursor to people feeling able and willing to access and enjoy natural environments. We did not find a similar pattern of stress for participants who noticed views to woodlands or green spaces when walking about their neighbourhood, suggesting that it is nature visits, rather than views of nature, that are associated with any stress buffering effect. However, for mental well-being, views of nature were not associated with a significant decline, whereas those without nature views showed significant declines in mental well-being in both panels A and B, suggesting some beneficial effect from views of nature in support of mental well-being.

The effect of changes to the physical woodland environment alone compared with the combined effect of physical and social interventions

We explored whether physical interventions in the environment were sufficient to produce beneficial effects in health or awareness of the woodlands or whether promotional activities, such as led walks and other community initiatives, were also needed to produce significant change. The core survey results indicate that neither of the intervention phases was sufficient to produce a community-level benefit in mental health. However, we did find a significant effect with regard to awareness of the local woods. Compared with the control site participants, intervention site participants increased awareness of local woods to a much greater degree. The intervention effect was large, held throughout the study (at both wave 2 and wave 3) and significant in both sample panels.

Although the site audits and qualitative findings suggest a positive response by participants to both the physical and social interventions, these participants represented only a very small minority of the community populations under study, because the core survey found that most did not engage with the woods and the facilitated community activities. Nonetheless, in the wave 2 survey, 23% of those in intervention sites who were aware of changes to the woodlands had read about them or (more commonly) heard about the changes from others. This indicates that there might be a greater effect from the interventions than participation in community engagement activities would suggest, and that word of mouth is an additional means by which to engage community members in natural environments. The focus groups also included participants who had become aware of their woods because of the social interventions only, suggesting that the phase 2 interventions were effective in increasing awareness, even if this was for only a comparatively small number of individuals.

Other health and well-being outcomes associated with the intervention

There was some evidence of the intervention being associated with other health and well-being outcomes. Measures of PA (IPAQ) showed a positive and significant association with the intervention group, especially for moderate levels of activity (both panels) and overall PA (for panel B at wave 3). This was notable compared with the control group, in which levels of PA went down over time. Although we cannot discount the possibility that (as with the increase in stress levels) this outcome is attributable to external factors other than the intervention, it is possible that the reported increase in the activity of walking in the local woods in the intervention sample compared with the control sample (see *Other behavioural, social and experiential outcomes associated with the intervention*) accounts for some part of this effect.

With regard to our other health-related outcomes, there was evidence of an increase in connectedness to nature by wave 3 of the survey for the intervention group compared with the control, but this was significant only for panel A. We found a similar pattern of comparative increase in social cohesion in the intervention group, significant both in wave 2 and wave 3, but only for panel A. The focus group findings illustrate a number of ways in which the interventions are likely to have influenced these outcomes. For example, participants enjoyed views of nature and wildlife and many were positive about facilitated community events with rangers that increased knowledge of the natural environment as well as events that engaged children and families.

Other behavioural, social and experiential outcomes associated with the intervention

Other outcomes identified in our research questions include the impact of the intervention on length and frequency of visits to natural areas and local woods, experience of local woods, awareness of them, activities undertaken there and visual contact with woodland.

The intervention did not show a significant association with length and frequency of visits to the specified local woods; this was analysed only for panel A owing to low total numbers visiting their local woods. However, there was a significant association, found in both panel A and panel B, between the intervention and those undertaking nature visits in general (i.e. to woodlands and other nearby green spaces) by wave 3. The increase in expected number of visits to nature was about 6% of the intervention sample. There was also a significant increase in those who had visual contact with nature, that is, those who were aware of views to woodlands or green spaces when walking about their neighbourhood. This was significant at wave 3 for panel A only.

Awareness of the local woods also increased significantly for the intervention group in both panels at waves 2 and 3. Panel A showed an increase of 13% in awareness of the local woodlands in the intervention sample between wave 1 and wave 3 and, for those who were aware, an increase in assessment of the quality of the local woodlands as good or very good from 26% in wave 1 to 51% in wave 3. The control sample showed a decline in all these measures, by comparison. For those who visited their local woods (a minority of participants; hence this was analysed only for panel A) there was a significant increase in going for a walk in the woods (at waves 2 and 3) and for walking with family and/or friends (wave 2 only).

The environmental audits by community members showed that the intervention woods were perceived as significantly better in quality than the control woods in the summer of 2015, when the wave 3 survey was undertaken, and significantly better quality than at baseline from summer 2014 onwards. This perceived enhancement of the physical environment may have contributed to greater use and awareness of the woods and other natural environments, although it is notable that the community auditors (unlike the expert auditors) scored the intervention woods significantly better in quality than the control woods at baseline too, in 2013. Focus group participants, many of whom visited their local woods, illustrated their positive response to the interventions in relation to walking in the woods and visiting with family, although for some the lack of longer term maintenance after the interventions was a problem for continuing such enhanced use of the woods over a year later.

We considered measures of experience of woodlands associated with attention restoration theory. We found a significant association between the intervention and both being away and fascination, and this was true for both panels. Such findings support a considerable literature on the restorative effects of experiences in nature[13,16] and point to potential psychophysiological responses that may have beneficial effects for health and well-being, including stress relief.[14,15] If woodlands need to be perceived as offering benefits for mental restoration or relief from stress before such benefits can be experienced, and perhaps before local woodlands are likely to be visited at all, then these findings point to a potential pathway by which mental health may improve over the longer term.

Any gender differences associated with impacts of the interventions

Although, on average, women were consistently associated with higher levels of stress than men, there was no significant difference in stress levels by gender. Furthermore, the audits and focus groups did not produce any notable differences in gender-based responses to the interventions.

Differences in impacts of the interventions in accordance with distance of woodlands from participants' homes

We found an association between distance to the local woodlands from home and stress outcomes. Differences in stress between intervention and control were largest in those living furthest away from the woods, with significantly higher stress for the intervention group (in both panels A and B) for those living ≤ 500 m from their local woodlands. This was especially notable when four rather than five distance bands were used in the analysis: two bands ≤ 500 m and two > 500 m. In panel B, when using five distance bands for analysis, increases in stress levels were not significantly different between control and intervention site participants living within 500 m of their local woodlands. These support findings from many other studies that consider the effect of distance from green and natural environments in determining any beneficial effect from nature, with the threshold of 500 m one limit of influence often cited,[96,97] although a closer limit of 300 m has recently been recommended for consideration by the WHO.[98] These findings suggest that proximity to woodlands may play a role in any stress buffering effects found from engagement with natural environments.

Cost consequences of the intervention in relation to the primary and secondary outcomes of the study

In terms of economic evaluation, there is no basis for demonstrating cost-effectiveness because the interventions were not associated with any significant enhancement of HRQoL. However, the CCA shows that the WIAT interventions are low cost and have the potential to provide benefits other than mental health benefits, such as improvements in moderate physical activities, walking activities, connectedness to nature and social cohesion. The overall CUA reveals an incremental ICER of £935 (95% CI £399 per QALY to dominated) in wave 2 for the physical (phase 1) intervention and £662 per QALY in wave 3 (95% CI £206 per QALY to dominated) for both physical and social (phase 2) interventions in panel A. The cost per QALY in panel B is £361 (95% CI £160 per QALY to dominated) for wave 2 after the physical (phase 1) intervention and £165 (95% CI £71 per QALY to dominated) for wave 3, after both physical and social (phase 2) interventions. This suggests that even small benefits in HRQoL, if found perhaps after a longer term evaluation of the WIAT interventions, have the potential to be relatively cost-effective at WTP of £20,000.

Implications of the findings

An overview of the study outcomes shows that the comparatively low-cost and small-scale environmental and community engagement interventions of the WIAT programme have not been associated with major positive changes in community behaviours and health outcomes; rather, they are associated with negative outcomes in the primary measures of mental health.

We cannot fully explain the significant association between the interventions and higher stress levels, for which the literature offers little support. Churn within the populations under study, urban and housing renewal programmes, noise pollution and similar external influences may explain the patterns of stress in this study, which appear to be largely independent of participants' engagement with the interventions. In the panel B cohort sample, for example, the negative stress patterns associated with the intervention are significant only for those not visiting nature. The effect of distance from the woodlands that was found in this study – that is, only those living > 500 m from their local woodlands showed significantly higher stress levels in the intervention group – also supports this interpretation.

The study does reveal some findings that suggest that the interventions may have had an effect on pathways to beneficial outcomes, as described in our logic model (see *Figure 1*). *Table 32* maps the findings from our different methods onto the pathways and outcomes predicted in the logic model. Increased visits to natural areas, including but not confined to the local woodlands, has been added to the model in this chart, as has people finding the woods restorative, because these were significant findings supported by more than one source of evidence.

The significant increases in awareness of local woods and visits to natural environments, such as woods and green spaces, suggest that some aspects of the 'enhanced environment' and 'behaviour outcomes' in the model have been influenced by the intervention. The positive increase in indicators associated with attention restoration theory[13,99] suggests that these engagements with nature have the potential to offer

TABLE 32 Proximal and distal outcomes: evidence from study results in relation to the logic model (see *Figure 1*)

Outcome	Quantitative survey		Community-led site audits	Community focus groups
	Panel A	Panel B		
Enhanced environment				
Woods more accessible	n/a	n/a	+	+
Woods more aesthetically attractive	n/a	n/a	+	+
Woods feel safer to use	n/a	n/a	+	+/–
Woods well maintained	n/a	n/a	+	+/–
Social support for environmental use				
People know more about local woods	+	+	n/a	+/–
Community engagement in decisions about woodland management	n/a	n/a	n/a	–
Supervised community activities in woods	n/a	n/a	n/a	+
Behaviour outcomes				
People visit woods more often	(ns)	(ns)	n/a	+/–
People visit nature more often	+	+	n/a	+/–
People take greater pleasure in views of woods/ nature	+	(ns)	n/a	+
Health outcomes				
Lower stress	–	–	n/a	n/a
Better mental well-being	–	–	n/a	n/a
HRQoL	(ns)	(ns)	n/a	n/a
Health-related outcomes				
Physical activity increases	(ns)	+	n/a	+/–
Connectedness with nature increases	+	(ns)	n/a	+
Better community awareness/cohesion	+	(ns)	n/a	+/–
People find woods restorative	+	+	n/a	+

+, positive outcome; –, negative outcome; +/–, both positive and negative outcomes; (ns), outcome not significant; n/a, not applicable.

Note

Dark green shading indicates significant outcomes not anticipated in the original logic model (see *Figure 1*).

therapeutic benefits associated with restorative environments. Although the results for PA, connectedness with nature and community cohesion were modest, they also suggest that there is a potential pathway to health-related outcomes that might eventually lead to better mental well-being and lower perceived stress levels. However, our findings suggest that any such effects would need to be experienced by a larger proportion of the population than was the case in this study for a community-level benefit in mental health to be likely.

Although the core survey indicated that the interventions had comparatively low reach into the relevant communities, the qualitative evidence suggests that when the WIAT programme did manage to engage people in the natural environment, it encouraged them to undertake activities in that environment, either alone or with others, and to enjoy the peace and calm and the views of wildlife that could be found there. The fact that significant intervention effects were found on PA, most notably after the phase 2 social interventions (i.e. by wave 3) for panel B, suggests that any wider interest in the natural environment and its use that might be associated with levels of PA may have been engendered by the community engagement activities. This accords with a recent systematic review that concluded that multifaceted urban green space interventions that incorporate physical changes and promotional/engagement activities are likely to have a more significant impact than interventions focused solely on physical changes.[44]

Records of meetings with FCS throughout the study suggest that the interventions were appropriate in terms of delivering typical WIAT projects, although more tightly constrained by time than would be typical. The reflective workshop held by FCS and Forest Research after the interventions were completed indicated that a 12- to 18-month delivery phase for each stage of intervention, and greater overlap between physical environmental changes and social interventions, would have been beneficial.[60] This workshop also noted that most successful previous FCS interventions under WIAT have involved several waves of intervention over 4–5 years and an even longer period before community use and knowledge of the WIAT woodland became habitual at any particular site. Therefore, it is possible that, given a greater length of time post intervention, some of the secondary outcomes found in this study might lead to a measurable beneficial difference in the primary outcome measure – perceived stress levels (PSS) – or the secondary measures of mental well-being (SWEMWBS) or HRQoL.

However, one of the findings from the qualitative data is that the decline in maintenance levels – once the interventions had been completed and FCS investment ceased – led to noticeable deterioration in the quality of the woods and their attractiveness for use by 2017, nearly 2 years later. It is a common problem for projects such as WIAT to commence with capital investment but to fail to reach an agreement with landowners or those managing the site over the cost of ongoing maintenance. FCS had not been able to agree longer term maintenance with councils or site landowners, and this was reflected in the negative comments about intervention site maintenance from the 2017 community focus groups and interviews. FCS reflected that it would have been beneficial to have outlined a longer term plan for the intervention sites at the start of the WIAT process for these sites.[60] These reflections suggest that without longer term plans for maintenance of the environment after WIAT interventions are completed, any beneficial effect of physical or social interventions is likely to decline over time. Nonetheless, it is notable that, even in 2017, the qualitative findings show many positive responses to the interventions and appreciation of the woods' accessibility, usability, contributions to enjoyment of nature and peace and quiet, etc. On balance, many benefits of the interventions were still being enjoyed nearly 2 years later by those who visited the woods; the population-level effect of visits remained very small, however, because so few of the community had started to visit the woods or any other green space more often than at baseline.

Public involvement in the research

Although essential to the project, securing public participation in the research was often quite difficult, with recruitment to the survey, audits and focus groups all proving challenging. There were differences in levels of participation across the intervention and control sites. For the community-led environmental audits, for

example, levels of participation at control site A were always much lower than at the other five sites. Despite the best efforts of the study team, no members of the community could be recruited to the winter 2013 audit at this site. We found that an active civil society, in the form of community and voluntary groups and community leaders/activists, helped facilitate higher levels of public involvement in our research. These individuals and groups helped raise awareness of this study and encouraged individuals to participate. Where such groups and individuals were absent, it was more difficult to generate interest in taking part.

Follow-on funding from the Economic and Social Research Council's Impact Acceleration awards to the University of Edinburgh and University of Glasgow was secured in 2017 to support 12 months of dedicated public and stakeholder engagement activity to assist in the dissemination of the study findings. Programmed activities included a high-level stakeholder workshop hosted by the Scottish Government to inform the production of policy briefings, seminars to share findings and their implications and seminars and workshops in partnership with FCS and Scottish Natural Heritage targeting other land agencies and third sector organisations. It is also proposed to work with FCS to produce further research on, and guidance on practice for, the WIAT delivery model, including the use of accessible media and community events. In designing these activities, we worked closely with the Scottish Government and FCS as well as the study communities to enhance knowledge exchange.

Challenges and limitations

Choice of study sites

One major challenge for this study was identifying appropriate sites for intervention and control arms of the study and matching them in terms of community characteristics.

The choice of sites and implementation of interventions were typical of the WIAT programme in terms of community characteristics and nature of woodlands. The sites were well matched on the aggregate socioeconomic characteristics of the community and matched as well as possible (given the other constraints) on the physical arrangement of the woodlands and community. There were no better matching sites available to us that met all the inclusion criteria. However, as noted above, FCS report that the time scale for planning, preparation, delivery and evaluation of the interventions was shorter than is considered ideal for the WIAT programme. The choice of sites was based on those eligible for funding support under the FCS WIAT programme. However, there were additional criteria required for this study, which included the requirement to match each intervention site as closely as possible with a control site, and the need to manage the timing of interventions to suit the study schedule and programme of community surveys. It was necessary to choose sites that best matched the research requirements rather than those whose characteristics and communities appeared most ready for engaging with WIAT.

The FCS reflective workshop suggested that, ideally, WIAT sites have pre-existing community groups able to engage with the woodland, or evidence of existing community use of the sites, and that negotiations with local authorities and other stakeholders about permission to operate in sites have already been carried out. They also considered that woodlands larger than intervention sites A and C were generally more successful for WIAT projects.[60]

In addition, the research time scale meant that the typical WIAT approach was compressed, with a short lead-in time to start the project at all three woodland sites, minimal local community and other stakeholder consultation prior to the project start and a compressed timetable (8–9 months) for delivery of each phase of the intervention. FCS staff reflected that, ideally, the social interventions in particular would be built over a longer period of time, perhaps 2–3 years.[60] FCS staff also considered that it would have been beneficial to have produced an outline longer term plan for the intervention sites at the start of the WIAT process for the study sites.[60] Thus, although every effort was made to implement the WIAT intervention in accordance with usual practice, it must be recognised that the requirements of the research study may have constrained the effectiveness of the interventions somewhat.

Study design

Although the study design drew on the existing relevant literature, both in terms of calculations of sample size and in choice of outcome measures, the lack of directly comparable studies based on natural experiments means that there may be limitations in terms of study power and in sensitivity of measures used. In particular, it is possible that the PSS, EQ-5D and SWEMWBS are not sensitive to any health and well-being benefits resulting from the WIAT interventions and that other measures better reflect any such outcomes.

There were challenges owing to the design of this study that are common to many environmental interventions. In general, it is not possible to randomise such studies, or the population who live in the intervention and comparison areas, meaning that it is always possible that there will be differences between the populations in intervention and comparison areas. We therefore have to rely on being able to control for fundamental differences through the regression models but for this we are restricted by the information collected in the survey. It is also possible that the results reflect interventions and external influences for which we have no data, which may have affected intervention and/or control sites in different ways.

As with many environmental intervention studies, this study had a limited number of sites: three intervention and three control sites. Because the site is the unit of intervention, we would expect some differences between sites in terms of the effectiveness of the intervention, yet the expense necessarily limits the number of sites that can receive the intervention or in which the surveys can be conducted. It is therefore difficult to account for variability in the success of the intervention between sites and to know whether or not the 'typical' effect of such an intervention has been seen.

It is also unfortunate that the study was not designed for further follow-up in subsequent years after the intervention, although this again would have had serious implications for the expense incurred for additional waves of the survey. It is possible that different PSS or other health effects might have been found after a longer period post intervention, although the findings suggest that this might be dependent on continuing investment in maintenance of the physical infrastructure and/or further social interventions to engage the local community.

Core survey sample

We faced considerable challenges in recruiting core survey participants. Although response rates were not as high as targeted, co-operation rates at each survey wave were at least 63% with a total co-operation rate of 70%. The literature confirms that response rates in epidemiological studies have in general been declining over recent years and highlights the particular challenges of recruitment in areas of deprivation.[74,100] Against this background, recruitment in a very deprived urban context proved extremely difficult. Although the response rates were not as high as we had initially targeted, we consider that the co-operation rates reflect a sample that is adequate for the study and realistic given these challenges.

However, the sample was reduced post recruitment, after data checks revealed concerns over some of the sample. This reduced the cross-sectional sample and led to a significantly smaller sample in some of the sites, in particular in intervention site A in both wave 2 and wave 3. We therefore had a less balanced sample in terms of sites than originally planned and this may have affected the results.

Despite our best attempts to match intervention and control sites based on environmental qualities and socioeconomic, area-level and health indicators, it was also notable that our cross-sectional (panel A) intervention sample showed greater levels of deprivation and poor health, indicated by significant negative differences compared with control participants in educational qualifications (waves 1 and 2) and in coping on income, smoking, access to a car and proximity to local woodlands in all three survey waves. There were also significantly lower numbers of intervention site dog owners in all three waves. All of these potentially have a bearing on woodland and natural environment use. In particular, higher affluence and social class have been shown to be associated with greater numbers of visits to outdoor environments for

leisure or recreation in Scotland.[101] This imbalance between the intervention and control sample characteristics may have been further exacerbated by the difference in patterns of proximity to the local woods. Although we attempted to match intervention and control communities and woodland sites on a variety of physical characteristics, the intervention sample finally used for analysis lived significantly further from their local woods than the control sample.

Recruitment of a longitudinal cohort within the sample was, as predicted, much less successful than the cross-sectional survey recruitment and means that we can have less confidence in the representativeness of the cohort sample. In addition, we found imbalances in levels of recruitment for different sites. In intervention site B, 45% of respondents in wave 3 of the survey were not the same individuals who responded in previous waves because they were 'not known' at the address. This seemed very high and the quality of these data was queried. Information from the local authority planning department indicated that there was a lot of churn within this community and people moved house within the public housing stock, adding to the challenge of retaining a longitudinal sample and perhaps to levels of stress within this population.

Recruitment for community site audits and focus groups

Recruitment of audit participants and focus groups via the survey was very challenging, with particular difficulty experienced in recruiting from the community in control site A. Despite efforts to increase recruitment by engaging with community groups and facilitators as the study progressed, those who did participate may not be typical of the communities from which they were drawn and are unlikely to reflect the views of many subgroups within that community. After substantial effort to recruit more widely, there were higher recruitment numbers, and from different participants, in focus groups or interviews in February 2017 than in November 2015. However, the time difference between the two means that their findings are not directly comparable, with the latter reflecting attitudes to and experience of sites no longer maintained by FCS > 20 months after the core survey was undertaken and the interventions completed.

Economic analysis

In the CUA, the time horizon for the analysis was assumed to be up to 2 years for the costing of the WIAT interventions. The full cost of the physical intervention was incurred in the first year. In the second year, the social intervention was added to the cost of the physical intervention. QALY gains were estimated for the year in which they would be measured. For this reason, there is an overestimation of cost because of the way that the CUA was conducted. In reality, the physical intervention could last in perpetuity if additional resources are employed to maintain the physical intervention. A model could have been developed to estimate the annual equivalent cost of the physical intervention assuming a percentage maintenance cost appropriately discounted into the future. This would have had the effect of reducing the physical intervention cost. However, we saw little advantage of adding this extra step because (1) the cost of the WIAT interventions is already very low, so they effectively provide an upper bound in the CUA and (2) the main uncertainty is the lack of evidence of the effect on HRQoL utility. Refining the cost estimation does not change the conclusion that the WIAT interventions cost very little and that the main uncertainty is whether or not there is a measurable effect on HRQoL. Our main conclusion stands: given the modest cost of the interventions, WIAT would need to have only a small impact on HRQoL to show cost-effectiveness. The problem remains, however, in being able to show small changes in HRQoL in the context of a population sample.

Principal contributions of the study

This study is the first of its kind, so far as we are aware, designed as a prospective study, where planned interventions to enhance urban populations' access to natural environments provided a 'natural experiment' and the health and quality-of-life impacts of the interventions were evaluated at a community level over time. As the literature overview underlines, the evidence on the relationship between engagement with natural environments and mental health for deprived urban populations is almost entirely observational, largely based on population-level analysis and often at a single point in time.[98] Although previous evidence showed that the impacts of access to natural environments appear particularly beneficial for deprived urban

populations[25,102] and that socioeconomic health inequalities are narrower among urban populations with greater access to natural environments,[103] there was little evidence on how interventions to improve access to nature might enhance health, nor how any such interventions might best be achieved.[44]

Despite the limitations acknowledged above, WIAT is an intervention that has the potential to improve health and reduce health inequalities and, for this reason, it is important that it should be evaluated. Our evaluation was enhanced by a number of factors, including primary data collection, the embedded longitudinal component, a qualitative study and a mixed-methods approach. A single evaluation such as this may not be definitive in all aspects but, as the first of its kind in relation to natural environments near disadvantaged urban communities, it contributes to a bigger picture of the impact of environmental interventions, health and quality of life.

The outcomes suggest that it would be valuable to find a way of increasing the number of sites considered in such a study – that is, in which natural experiments do not allow for random allocation of participants to different treatments. If more routinely collected data could provide appropriately sensitive and granular data on health outcomes, such an approach could be appropriate, building on our findings. However, the detailed understanding of site-specific issues and community perceptions via the mixed-methods approach has also provided insights that would otherwise be unavailable. The findings suggest that physical interventions alone make a noticeable contribution but that the reach of such interventions is small in terms of community numbers and behaviour change. Although the costs of the interventions were modest, it is possible that longer term commitment to funding post-intervention maintenance and community engagement may be needed to achieve significant health benefits.

One strength of the study lies in its policy relevance. At national and international levels there is interest in finding affordable ways to enhance the environment to achieve area-level health benefits and offer preventative approaches to public health.[4] In particular, there is a desire to understand what kinds of intervention in the natural environment (such as those of the WIAT programme) are effective at a community level, and the limitations to their effectiveness.[51] This study offers an increased understanding of such interventions and ways to research them.

The study is underpinned by a clear theoretical model and the findings offer some support for the pathways indicated in the model between interventions in the natural environment and health outcomes. Findings also demonstrate the challenges of undertaking studies based on natural experiments such as this and offer directions for future research as well as a better understanding of the challenges involved.

Chapter 7 Conclusions

This study did not find the primary predicted outcome. The WIAT programme interventions did not lead to lower perceived stress levels and better mental well-being in the intervention sample; rather, we found the opposite outcome associated with the interventions. This may reflect social, economic or environmental influences external to the interventions that the study was unable to account for, although our qualitative findings suggest some possibilities. It may also reflect some of the limitations of the study, including the relatively low number of sites included in intervention and control arms and the relatively short time frame post intervention in which the outcomes were measured. This finding illustrates the methodological challenges of undertaking research in this area and in using natural experiments. This study has contributed to a better understanding of these challenges.

Findings from our secondary outcome measures suggest that some of the pathways to better health from improved access to urban woodlands may act as predicted in our logic model. The results need to be interpreted with caution given evidence of potential environmental factors external to the intervention that may be influencing health outcomes in our sample. Nonetheless, we found evidence that the WIAT intervention predicted increases in levels of moderate-level PA for those participants who visited natural environments (i.e. the woodlands and nearby green space) more often post intervention. There was also some evidence that the intervention increased participants' feelings of connectedness with nature and community cohesion, both potential pathways to health and quality of life.

The findings offer support for other outcomes associated with the WIAT programme: increased visits to natural areas, increased awareness of the local woods and perceived enhancement in the restorative quality of woodlands. Although the size of the effect of these findings on each community as a whole is not very large, there is consistent evidence from the mixed-methods approach to show that the intervention has played a role in these outcomes.

The economic evaluation suggests that, although the primary outcome of PSS and secondary outcomes, such as the EQ-5D HRQoL, were insignificant, the WIAT programme has the potential to offer other outcomes, such as increases in moderate physical activities, walking activities, connectedness to nature and social cohesion. The CUA suggests that if the physical intervention has a long lifespan (i.e. is subsequently well maintained) it has the potential to be relatively cost-effective for even small increases in HRQoL.

Recommendations for future research

A principal challenge identified in this study relates to the difficulty in obtaining a sample of sufficient size and balance between intervention and control sites to evaluate environmental interventions, such as WIAT, if there is likely to be considerable variation between individual community characteristics. For future research, we recommend increasing the number of sites considered in such a study, that is in which natural experiments do not allow for random allocation of participants to different treatments. However, given the high cost of primary data collection, we also recommend the use of routinely collected data wherever possible, rather than basing evaluations on primary data collection. Such an approach, for example, would enable a whole-programme evaluation of WIAT, covering considerably more sites and over many more years.

Our findings show evidence of some intervention effect of WIAT on health-related outcomes, such as PA, connectedness to nature and community cohesion, which may act as pathways to benefit for mental health in the longer term. Reflections from the FCS also suggest that the community engagement aspect of WIAT needs longer than 1 year to be effective in reaching into deprived communities and ongoing physical maintenance of WIAT sites is important as part of this. We therefore recommend that future studies of interventions such as WIAT are evaluated for mental health and other health-related outcomes over a longer period. Again, the use of routinely collected data would facilitate this, both retrospectively

and prospectively. Consideration of routine data to evaluate outcomes might also offer different opportunities for use of outcome measures that might be more sensitive than PSS, SWEMWBS or EQ-5D to interventions such as WIAT.

If, in future, environmental interventions such as WIAT are considered for evaluation, it is recommended that there is greater engagement with local community members and groups, not only after any physical intervention but also prior to any intervention, to co-produce proposals for change. In addition, negotiations with land owners, local authorities and/or other stakeholders would ideally ensure, from the outset, a commitment to longer term maintenance of intervention sites post completion.

Future research could usefully test our theoretical model and the pathways indicated in the model between interventions in the natural environment and health outcomes, as well as those added as a result of our findings. Despite the challenges of quasi-experimental design and research based on natural experiments in relation to green and natural environments, this study has shown how this can be done. Given the growing interest in better understanding how interventions in green space and natural environments can enhance health and reduce health inequalities,[50] further testing of our methods and the modelling that underlies it could make an important contribution to public health.

Finally, it is important to acknowledge that the complex systems that influence health outcomes also reflect influences over the lifecourse that may interact with short-term interventions such as the intervention that this study evaluated, and these are particularly pertinent for deprived communities.[104] Such an approach challenges linear models of environment–health causality.[105] Short-term interventions such as WIAT may be unable to affect health outcomes driven by wider, lifelong factors. We recommend consideration of techniques to explore where best to intervene in the complex system to maximise benefits for mental health from environmental exposures for different groups within the population. Such techniques might include, for example, agent-based modelling to consider which aspects of people's lives and communities are most likely to increase beneficial contact with nature.

Acknowledgements

Wider contributions

The authors thank the study participants, many of whom contributed to more than one part of the study over 2 or 3 years. Agnès Patuano, Omar Mohammed and Mei-Lin Su assisted with field work, expert and community-led environmental audits and qualitative data collection via focus groups.

Catriona Graham (Wellcome Clinical Trials Unit) and Stephanie Lewis (Centre for Population Health Sciences), University of Edinburgh, assisted with the initial statistical advice in preparing the study design. Anna Orme, Jacqueline McMahon, Sue Coleman, Hamish Macandrew and Gordon Whittaker, University of Edinburgh, assisted with financial management and administrative support for the study.

Marcus Sangster, James Ogilvie, Bob Frost and Brent Meakin, Forestry Commission and FCS, contributed to the early conception of the study and pilot research that led to the final study design. Mike Kerr and Howard Davies assisted with GIS data and selection of case study sites and Bob Frost, Stuart Chalmers, Brent Meakin, Douglas Knox, Matthew Buckland, Colin Peacock, John Ogilvie, Roddy McTavish, Hugh McNish and Kevin Lafferty, all FCS, contributed to many different parts of the planning, delivery and recording of interventions for the study. Graham Hardie (Woodland Learning Adventures) contributed to delivery of the social interventions. Liz Murphy, Susan Cummins, Diane McGregor and Bill McDivitt of Progressive Partnership managed the administration of the community surveys and delivery of data from them.

Bianca Ambrose-Oji and Liz O'Brien, Forest Research, guided FCS reflections on the intervention outcomes. Terry Hartig, University of Uppsala, and Liz O'Brien, Forest Research, gave expert advice on the study design, execution and its interpretation, including contributing to the SSC in the study's later stages. George Morris chaired our SSC and Marise Bucukoglu, Darren Chant, Mark Petticrew, Marcus Sangster, Lorraine Tulloch, Peter Craig and Carol Brown were members of the SSC for some or all of the study duration. Lewis Bradley and Margarida Resende were NIHR Research Managers for the project.

Contributions of authors

Catharine Ward Thompson (Professor of Landscape Architecture and Director, OPENspace Research Centre, University of Edinburgh) was principal investigator for the study; she led the study design and its execution, oversaw the analyses and interpretation of all findings and led production of the final report.

Eva Silveirinha de Oliveira (Joint Study Manager and Research Fellow, OPENspace Research Centre, University of Edinburgh) contributed to the execution and oversight of the study in general, undertook study fieldwork, oversaw the management of data collection and contributed to study analyses and publications.

Sara Tilley (Joint Study Manager and Research Fellow, OPENspace Research Centre, University of Edinburgh) contributed to the execution and oversight of the study in general, undertook study fieldwork, oversaw the management of data collection and contributed to study analyses, publications and all sections of the final report.

Aldo Elizalde [Research Associate, Medical Research Council/Chief Scientist Office (MRC/CSO) Social and Public Health Sciences Unit, University of Glasgow] led multiple statistical analyses for the study, led the preparation of sections of the final report and contributed to all sections.

Willings Botha (Health Economics and Health Technology Assessment, Institute of Health and Wellbeing, University of Glasgow) led multiple health economics analyses for the study and led the preparation of sections of the final report.

Andrew Briggs (Professor of Health Economics, Health Economics and Health Technology Assessment, Institute of Health and Wellbeing, University of Glasgow) oversaw the health economics aspects of the study design and analyses and contributed to the preparation of sections of the final report.

Steve Cummins (Professor of Population Health, Department of Social and Environmental Health Research, London School of Hygiene & Tropical Medicine) contributed to the design, execution and oversight of the study in general, including interpretation of findings, and contributed to all sections of the report.

Alastair H Leyland (Associate Director, MRC/CSO Social and Public Health Sciences Unit, University of Glasgow) contributed to the oversight of the study in general, oversaw the principal statistical analyses for the study and contributed to all sections of the final report.

Jenny J Roe (Heriot-Watt University, University of York and University of Virginia) contributed to the design, execution and oversight of the study in general, contributed to the qualitative research and application of the community audit tool, the interpretation of data findings and to all sections of the final report.

Peter Aspinall (Professor Emeritus, Heriot-Watt University) contributed to the design, execution and oversight of the study in general, including initial data analyses and interpretation.

Katherine Brookfield (Research Fellow, OPENspace Research Centre, University of Edinburgh) contributed to qualitative study analyses and certain sections of the final report.

Richard Mitchell (Programme Leader – Neighbourhoods and Communities, MRC/CSO Social and Public Health Sciences Unit, University of Glasgow) contributed to the design, execution and oversight of the study in general, including key study analyses and interpretation of findings, and contributed to all sections of the final report.

All authors contributed to the design of the final report and approved the final version.

Publication

Silveirinha de Oliveira E, Aspinall P, Briggs A, Cummins S, Leyland AH, Mitchell R, *et al.* How effective is the Forestry Commission Scotland's woodland improvement programme – 'Woods In and Around Towns' (WIAT) – at improving psychological well-being in deprived urban communities? A quasi-experimental study. *BMJ Open* 2013;**3**:e003648.

Data-sharing statement

Anonymised core survey and environmental audit data are available to the scientific community with as few restrictions as feasible. All available qualitative data arising from focus groups and interviews are contained in the report and nothing further can be shared. Please note that the authors intend to retain exclusive use until the publication of major outputs. All enquiries and data requests should be submitted to the corresponding author. Access to available anonymised data may be granted following review.

References

1. Wittchen HU, Jacobi F. Size and burden of mental disorders in Europe – a critical review and appraisal of 27 studies. *Eur Neuropsychopharmacol* 2005;**15**:357–76. https://doi.org/10.1016/j.euroneuro.2005.04.012
2. Scottish Association for Mental Health (SAMH). *What's it Worth Now? The Social and Economic Costs of Mental Health Problems in Scotland*. Glasgow: SAMH; 2011.
3. Pearce JR, Richardson EA, Mitchell RJ, Shortt NK. Environmental justice and health: the implications of the socio-spatial distribution of multiple environmental deprivation for health inequalities in the United Kingdom. *Trans Inst Br Geogr* 2010;**35**:522–39. https://doi.org/10.1111/j.1475-5661.2010.00399.x
4. Morris GP, Beck SA, Hanlon P, Robertson R. Getting strategic about the environment and health. *Public Health* 2006;**120**:889–903. https://doi.org/10.1016/j.puhe.2006.05.022
5. Lee ACK, Maheswaran R. The health benefits of urban green spaces: a review of the evidence. *J Public Health* 2011;**33**:212–22. https://doi.org/10.1093/pubmed/fdq068
6. Mitchell R, Astell-Burt T, Richardson EA. A comparison of green space indicators for epidemiological research. *J Epidemiol Community Health* 2011;**65**:853–8. https://doi.org/10.1136/jech.2010.119172
7. Tsunetsugu Y, Park BJ, Miyazaki Y. Trends in research related to 'Shinrin-yoku' (taking in the forest atmosphere or forest bathing) in Japan. *Environ Health Prev Med* 2010;**15**:27–37. https://doi.org/10.1007/s12199-009-0091-z
8. de Vries S. Nearby Nature and Human Health: Looking At Mechanisms and Their Implications. In Ward Thompson C, Bell S, Aspinall P, editors. *Innovative Approaches to Researching Landscape and Health*. Oxford: Routledge; 2010. pp. 77–96.
9. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. *CMAJ* 2006;**174**:801–9. https://doi.org/10.1503/cmaj.051351
10. Uchino BN. Social support and health: a review of physiological processes potentially underlying links to disease outcomes. *J Behav Med* 2006;**29**:377–87. https://doi.org/10.1007/s10865-006-9056-5
11. Cohen S. Social relationships and health. *Am Psychol* 2004;**59**:676–84. https://doi.org/10.1037/0003-066X.59.8.676
12. Sternberg EM. *Healing Spaces: the Science of Place and Well-being*. Cambridge, MA: Harvard University Press; 2009.
13. Hartig T, Mang M, Evans GW. Restorative effects of natural environment experiences. *Environ Behav* 1991;**23**:3–26. https://doi.org/10.1177/0013916591231001
14. Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, Zelson M. Stress recovery during exposure to natural and urban environments. *J Environ Psychol* 1991;**11**:201–30. https://doi.org/10.1016/s0272-4944(05)80184-7
15. Park BJ, Tsunetsugu Y, Kasetani T, Kagawa T, Miyazaki Y. The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan. *Environ Health Prev Med* 2010;**15**:18–26. https://doi.org/10.1007/s12199-009-0086-9

16. Ulrich RS. Aesthetic and Affective Response to Natural Environment. In Altman I, Wohlwill JF, editors. *Human Behaviour and Environment: Advances in Theory and Research, Vol. 6: Behaviour and the Natural Environment*. New York, NY: Plenum Press; 1983. pp. 85–125.

17. Kaplan R, Kaplan S. *The Experience of Nature: A Psychological Perspective*. New York, NY: Cambridge University Press; 1989.

18. Kaplan S. The restorative benefits of nature: toward an integrative framework. *J Environ Psychol* 1995;**15**:169–82. https://doi.org/10.1016/0272-4944(95)90001-2

19. Dadvand P, de Nazelle A, Triguero-Mas M, Schembari A, Cirach M, Amoly E, *et al.* Surrounding greenness and exposure to air pollution during pregnancy: an analysis of personal monitoring data. *Environ Health Perspect* 2012;**120**:1286–90. https://doi.org/10.1289/ehp.1104609

20. Abhijith KV, Kumar P, Gallagher J, McNabola A, Baldauf R, Pilla F, *et al.* Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – a review. *Atmos Environ* 2017;**162**:71–86. https://doi.org/10.1016/j.atmosenv.2017.05.014

21. Maas J, Verheij RA, de Vries S, Spreeuwenberg P, Schellevis FG, Groenewegen PP. Morbidity is related to a green living environment. *J Epidemiol Community Health* 2009;**63**:967–73. https://doi.org/10.1136/jech.2008.079038

22. Maas J, Verheij RA, Groenewegen PP, de Vries S, Spreeuwenberg P. Green space, urbanity, and health: how strong is the relation? *J Epidemiol Community Health* 2006;**60**:587–92. https://doi.org/10.1136/jech.2005.043125

23. de Vries S, Verheij RA, Groenewegen PP, Spreeuwenberg P. Natural environments – healthy environments? An exploratory analysis of the relationship between greenspace and health. *Environ and Planning A* 2003;**35**:1717–31. https://doi.org/10.1068/a35111

24. Coutts C, Horner M, Chapin T. Using geographical information system to model the effects of green space accessibility on mortality in Florida. *Geocarto Int* 2010;**25**:471–84. https://doi.org/10.1080/10106049.2010.505302

25. Mitchell R, Popham F. Effect of exposure to natural environment on health inequalities: an observational population study. *Lancet* 2008;**372**:1655–60. https://doi.org/10.1016/S0140-6736(08)61689-X

26. Richardson EA, Mitchell R. Gender differences in relationships between urban green space and health in the United Kingdom. *Soc Sci Med* 2010;**71**:568–75. https://doi.org/10.1016/j.socscimed.2010.04.015

27. Stigsdotter UK, Ekholm O, Schipperijn J, Toftager M, Kamper-Jørgensen F, Randrup TB. Health promoting outdoor environments – associations between green space, and health, health-related quality of life and stress based on a Danish national representative survey. *Scand J Public Health* 2010;**38**:411–17. https://doi.org/10.1177/1403494810367468

28. Maat K, De Vries P. The influence of the residential environment on green-space travel: testing the compensation hypothesis. *Environ and Planning A* 2006;**38**:2111–27. https://doi.org/10.1068/a37448

29. Nielsen TS, Hansen KB. Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators. *Health Place* 2007;**13**:839–50. https://doi.org/10.1016/j.healthplace.2007.02.001

30. O'Brien E, Williams K, Stewart A. *Urban Health and Health Inequalities and the Role of Urban Forestry in Britain: A Review*. Farnham: Forest Research; 2010.

31. Sugiyama T, Francis J, Middleton NJ, Owen N, Giles-Corti B. Associations between recreational walking and attractiveness, size, and proximity of neighborhood open spaces. *Am J Public Health* 2010;**100**:1752–7. https://doi.org/10.2105/AJPH.2009.182006

32. MRC. *Using Natural Experiments to Evaluate Population Health Interventions*. London: MRC; 2011.

33. FCS. *Woods In and Around Towns (WIAT)*. URL: www.forestry.gov.uk/wiat (accessed 6 December 2010).

34. Thompson CW, Roe J, Aspinall P. Woodland improvements in deprived urban communities: what impact do they have on people's activities and quality of life? *Landsc Urban Plan* 2013;**118**:79–89. https://doi.org/10.1016/j.landurbplan.2013.02.001

35. Moore GF, Audrey S, Barker M, Bond L, Bonell C, Hardeman W, *et al. Process Evaluation of Complex Interventions: Medical Research Council Guidance*. London: MRC Population Health Science Research Network; 2014.

36. Egorov AI, Mudu P, Braubach M, Martuzzi M. *Urban Green Spaces and Health: A Review of the Evidence*. Copenhagen: WHO; 2016.

37. Alcock I, White MP, Wheeler BW, Fleming LE, Depledge MH. Longitudinal effects on mental health of moving to greener and less green urban areas. *Environ Sci Technol* 2014;**48**:1247–55. https://doi.org/10.1021/es403688w

38. White MP, Alcock I, Wheeler BW, Depledge MH. Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. *Psychol Sci* 2013;**24**:920–8. https://doi.org/10.1177/0956797612464659

39. Beyer KM, Kaltenbach A, Szabo A, Bogar S, Nieto FJ, Malecki KM. Exposure to neighborhood green space and mental health: evidence from the survey of the health of Wisconsin. *Int J Environ Res Public Health* 2014;**11**:3453–72. https://doi.org/10.3390/ijerph110303453

40. van den Bosch MA, Östergren PO, Grahn P, Skärbäck E, Währborg P. Moving to serene nature may prevent poor mental health – results from a Swedish longitudinal cohort study. *Int J Environ Res Public Health* 2015;**12**:7974–89. https://doi.org/10.3390/ijerph120707974

41. Pope D, Tisdall R, Middleton J, Verma A, Van Ameijden E, Birt C, *et al.* Quality of and access to green space in relation to psychological distress: results from a population-based cross-sectional study as part of the EURO-URHIS 2 project. *Eur J Public Health* 2018;**28**:35–8. https://doi.org/10.1093/eurpub/ckx217

42. Reklaitiene R, Grazuleviciene R, Dedele A, Virviciute D, Vensloviene J, Tamosiunas A, *et al.* The relationship of green space, depressive symptoms and perceived general health in urban population. *Scand J Public Health* 2014;**42**:669–76. https://doi.org/10.1177/1403494814544494

43. van den Berg M, van Poppel M, van Kamp I, Andrusaityte S, Balseviciene B, Cirach M, *et al.* Visiting green space is associated with mental health and vitality: a cross-sectional study in four European cities. *Health Place* 2016;**38**:8–15. https://doi.org/10.1016/j.healthplace.2016.01.003

44. Hunter R, Cleary A, Cleland C. *An Evidence Review on the Environmental, Health and Equity Effects of Urban Green Space Interventions*. Copenhagen: WHO Regional Office for Europe; 2017.

45. Kuo FE, Sullivan WC. Aggression and violence in the inner city effects of environment via mental fatigue. *Environ Behav* 2001;**33**:543–71. https://doi.org/10.1177/00139160121973124

46. Kuo FE. Coping with poverty: impacts of environment and attention in the inner city. *Environ Behav* 2001;**33**:5–34. https://doi.org/10.1177/00139160121972846

47. Francis J, Wood LJ, Knuiman M, Giles-Corti B. Quality or quantity? Exploring the relationship between Public Open Space attributes and mental health in Perth, Western Australia. *Soc Sci Med* 2012;**74**:1570–7. https://doi.org/10.1016/j.socscimed.2012.01.032

48. Jiang B, Chang C-Y, Sullivan WC. A dose of nature: tree cover, stress reduction, and gender differences. *Landsc Urban Plan* 2014;**132**:26–36. https://doi.org/10.1016/j.landurbplan.2014.08.005

49. Jiang B, Li D, Larsen L, Sullivan WC. A dose-response curve describing the relationship between urban tree cover density and self-reported stress recovery. *Environ Behav* 2016;**48**:607–29. https://doi.org/10.1177/0013916514552321

50. WHO. *Urban Green Space Interventions and Health: A Review of Impacts and Effectiveness*. Copenhagen: WHO Regional Office for Europe; 2017.

51. Rebmann A, Cleary A, Braubach M. *Good Practice and Lessons Learned: A Review of Urban Green Space Intervention Case Studies*. Copenhagen: WHO Regional Office for Europe; 2017.

52. Branas CC, Cheney RA, MacDonald JM, Tam VW, Jackson TD, Ten Have TR. A difference-in-differences analysis of health, safety, and greening vacant urban space. *Am J Epidemiol* 2011;**174**:1296–306. https://doi.org/10.1093/aje/kwr273

53. Kondo MC, Low SC, Henning J, Branas CC. The impact of green stormwater infrastructure installation on surrounding health and safety. *Am J Public Health* 2015;**105**:e114–21. https://doi.org/10.2105/AJPH.2014.302314

54. Gubbels JS, Kremers SP, Droomers M, Hoefnagels C, Stronks K, Hosman C, de Vries S. The impact of greenery on physical activity and mental health of adolescent and adult residents of deprived neighborhoods: a longitudinal study. *Health Place* 2016;**40**:153–60. https://doi.org/10.1016/j.healthplace.2016.06.002

55. Thompson Coon J, Boddy K, Stein K, Whear R, Barton J, Depledge MH. Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environ Sci Technol* 2011;**45**:1761–72. https://doi.org/10.1021/es102947t

56. Bowler DE, Buyung-Ali LM, Knight TM, Pullin AS. A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health* 2010;**10**:456. https://doi.org/10.1186/1471-2458-10-456

57. Silveirinha de Oliveira E, Aspinall P, Briggs A, Cummins S, Leyland AH, Mitchell R, *et al.* How effective is the Forestry Commission Scotland's woodland improvement programme – 'Woods In and Around Towns' (WIAT) – at improving psychological well-being in deprived urban communities? A quasi-experimental study. *BMJ Open* 2013;**3**:e003648. https://doi.org/10.1136/bmjopen-2013-003648

58. Scottish Government. *Scottish Index of Multiple Deprivation*. 2012. URL: www.scotland.gov.uk/Topics/Statistics/SIMD (accessed 22 May 2013).

59. FCS. *Enhancing the Woodland User Experience: A Toolbox for Assessing Community Woodlands*. Edinburgh: FCS; 2013.

60. Ambrose-Oji B. *Reflections on the WIAT Health Research Project*. Edinburgh: Forest Research; 2016.

61. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983;**24**:385–96. https://doi.org/10.2307/2136404

62. Gonzalez MT, Hartig T, Patil GG, Martinsen EW, Kirkevold M. A prospective study of group cohesiveness in therapeutic horticulture for clinical depression. *Int J Ment Health Nurs* 2011;**20**:119–29. https://doi.org/10.1111/j.1447-0349.2010.00689.x

63. EuroQol. *EQ-5D*. EuroQol. 2017. URL: https://euroqol.org (accessed 1 August 2017).

64. Tennant R, Hiller L, Fishwick R, Platt S, Joseph S, Weich S, *et al.* The Warwick–Edinburgh Mental Well-being Scale (WEMWBS): development and UK validation. *Health Qual Life Outcomes* 2007;**5**:63. https://doi.org/10.1186/1477-7525-5-63

65. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, *et al.* International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003;**35**:1381–95. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

66. Ward Thompson C, Roe J, Aspinall P. *Woods In and Around Towns (WIAT): A Longitudinal Study Comparing Perceptions and Use of Woodlands Pre and Post-Intervention (2006–2009) – A Glasgow Case Study*. Edinburgh: FCS; 2010.

67. Scottish Government. *Scottish Environmental Attitudes and Behaviours Survey 2008*. Edinburgh: Scottish Government; 2009.

68. Commission for Architecture and the Built Environment (CABE). *Community Green: Using Local Spaces to Tackle Inequality and Improve Health*. London: CABE; 2010.

69. Department for Communities and Local Government. *Best Value User Satisfaction Surveys*. London: Department for Communities and Local Government; 2007.

70. Reid S, Curtice J. *Scottish Social Attitudes Survey 2009: Sustainable Places and Greenspace*. Edinburgh: Scottish Government; 2010.

71. Park JJ, O'Brien L, Roe J, Ward Thompson C, Mitchell R. The natural outdoors and health: assessing the value and potential contribution of secondary public data sets in the UK to current and future knowledge. *Health Place* 2011;**17**:269–79. https://doi.org/10.1016/j.healthplace.2010.11.005

72. Schultz PW. Inclusion with Nature: The Psychology of Human-Nature Relations. In Schmuck P, Schultz PW, editors. *Psychology of Sustainable Development*. Boston, MA: Springer; 2002. pp. 61–78. https://doi.org/10.1007/978-1-4615-0995-0_4

73. Poortinga W. Community resilience and health: the role of bonding, bridging, and linking aspects of social capital. *Health Place* 2012;**18**:286–95. https://doi.org/10.1016/j.healthplace.2011.09.017

74. Parry O, Bancroft A, Gnich W. Nobody at home? Issues of respondent recruitment in areas of deprivation. *Crit Pub Health* 2001;**11**:305–17. https://doi.org/10.1080/09581590110094585

75. Ward Thompson C, Roe J. *Tools for Evaluating the Impact of WIAT (Woods In and Around Towns) Intervention Sites*. Edinburgh: OPENspace; 2010.

76. Pope C, Ziebland S, Mays N. Analysing qualitative data. *BMJ* 2000;**320**:114–16. https://doi.org/10.1136/bmj.320.7227.114

77. Mogyorosy Z, Smith P. *The Main Methodological Issues in Costing Health Care Services: A Literature Review*. Working Papers 7. York: University of York; 2005.

78. McIntosh E, Clarke P, Frew E, Louviere J. *Applied Methods of Cost–Benefit Analysis in Health Care*. Oxford: Oxford University Press; 2010.

79. Dolan P. Modeling valuations for EuroQol health states. *Med Care* 1997;**35**:1095–108. https://doi.org/10.1097/00005650-199711000-00002

80. Devlin NJ, Shah KK, Feng Y, Mulhern B, van Hout B. Valuing health-related quality of life: an EQ-5D-5L value set for England. *Health Econ* 2018;**27**:7–22. https://doi.org/10.1002/hec.3564

81. Hernandez Alava M, Wailoo A, Grimm S, Pudney S, Gomes M, Sadique Z, *et al.* EQ-5D-5L versus EQ-5D-3L: the impact on cost effectiveness in the United Kingdom. *Value Health* 2018;**21**:49–56. https://doi.org/10.1016/j.jval.2017.09.004

82. NICE. *Guide to the Methods of Technology Appraisal 2013*. NICE. 2013. URL: www.nice.org.uk/process/pmg9/resources/guide-to-the-methods-of-technology-appraisal-2013-pdf-2007975843781 (accessed 1 August 2017).

83. van Hout B, Janssen MF, Feng YS, Kohlmann T, Busschbach J, Golicki D, *et al.* Interim scoring for the EQ-5D-5L: mapping the EQ-5D-5L to EQ-5D-3L value sets. *Value Health* 2012;**15**:708–15. https://doi.org/10.1016/j.jval.2012.02.008

84. Payne K, Thompson A. Economic Evaluations of Complex Interventions. In Richards D, Hallberg I, editors. *Complex Interventions in Health: An Overview of Research Methods*. 1st edn. London: Routledge; 2015.

85. Gray AM, Clarke PM, Wolstenholme JL, Wordsworth S. *Applied Methods of Cost-Effectiveness Analysis in Healthcare*. Oxford: Oxford University Press; 2010.

86. Briggs AH, O'Brien BJ. The death of cost-minimization analysis? *Health Econ* 2001;**10**:179–84. https://doi.org/10.1002/hec.584

87. Edlin R, McCabe C, Hulme C, Hall P, Wright J. *Cost Effectiveness Modelling for Health Technology Assessment: A Practical Course*. Heidelberg: Springer; 2015. https://doi.org/10.1007/978-3-319-15744-3

88. Briggs A, Sculpher M, Claxton K. *Decision Modelling for Health Economic Evaluation*. Oxford: Oxford University Press; 2006.

89. Karolinska Institutet. *IPAQ: International Physical Activity Questionnaire*. Stockholm: Karolinska Institutet; 2017. URL: https://sites.google.com/site/theipaq/ (accessed 22 August 2017).

90. NHS. *Physical Activity Guidelines for Adults*. 2015. URL: www.nhs.uk/Livewell/fitness/Pages/physical-activity-guidelines-for-adults.aspx (accessed 22 August 2017).

91. Briggs AH, Parfrey PS, Khan N, Tseng S, Dehmel B, Kubo Y, *et al.* Analyzing health-related quality of life in the EVOLVE trial: the joint impact of treatment and clinical events. *Med Decis Making* 2016;**36**:965–72. https://doi.org/10.1177/0272989X16638312

92. Manca A, Hawkins N, Sculpher MJ. Estimating mean QALYs in trial-based cost-effectiveness analysis: the importance of controlling for baseline utility. *Health Econ* 2005;**14**:487–96. https://doi.org/10.1002/hec.944

93. Morris S, Devlin N, Parkin D. *Economic Analysis in Health Care*. Chichester: Wiley; 2012.

94. van den Berg AE, Maas J, Verheij RA, Groenewegen PP. Green space as a buffer between stressful life events and health. *Soc Sci Med* 2010;**70**:1203–10. https://doi.org/10.1016/j.socscimed.2010.01.002

95. Wells NM, Evans GW. Nearby nature – a buffer of life stress among rural children. *Environ Behav* 2003;**35**:311–30. https://doi.org/10.1177/0013916503035003001

96. Dadvand P, Sunyer J, Basagaña X, Ballester F, Lertxundi A, Fernández-Somoano A, *et al.* Surrounding greenness and pregnancy outcomes in four Spanish birth cohorts. *Environ Health Perspect* 2012;**120**:1481–7. https://doi.org/10.1289/ehp.1205244

97. Wolch J, Jerrett M, Reynolds K, McConnell R, Chang R, Dahmann N, *et al.* Childhood obesity and proximity to urban parks and recreational resources: a longitudinal cohort study. *Health Place* 2011;**17**:207–14. https://doi.org/10.1016/j.healthplace.2010.10.001

98. WHO. *Urban Green Spaces and Health: A Review of Evidence*. Copenhagen: WHO Regional Office for Europe; 2016.

99. Hartig T. Three Steps to Understanding Restorative Environments as Health Resources. In Thompson CW, Travlou P, editors. *Open Space: People Space*. London: Taylor & Francis; 2007. pp. 16–79.

100. Galea S, Tracy M. Participation rates in epidemiologic studies. *Ann Epidemiol* 2007;**17**:643–53. https://doi.org/10.1016/j.annepidem.2007.03.013

101. Scottish Natural Heritage. *Scotland's People and Nature Survey 2013/14*. Inverness: Scottish Natural Heritage; 2014.

102. Roe JJ, Thompson CW, Aspinall PA, Brewer MJ, Duff EI, Miller D, *et al.* Green space and stress: evidence from cortisol measures in deprived urban communities. *Int J Environ Res Public Health* 2013;**10**:4086–103. https://doi.org/10.3390/ijerph10094086

103. Mitchell RJ, Richardson EA, Shortt NK, Pearce JR. Neighborhood environments and socioeconomic inequalities in mental well-being. *Am J Prev Med* 2015;**49**:80–4. https://doi.org/10.1016/j.amepre.2015.01.017

104. Pearce J, Cherrie M, Shortt N, Deary I, Ward Thompson C. Life course of place: a longitudinal study of mental health and place. *Trans Inst Br Geogr* 2018;**43**:555–72. https://doi.org/10.1111/tran.12246

105. Rutter H, Savona N, Glonti K, Bibby J, Cummins S, Finegood DT, *et al.* The need for a complex systems model of evidence for public health. *Lancet* 2017;**390**:2602–4. https://doi.org/10.1016/S0140-6736(17)31267-9

Appendix 1 Site plans for Woods In and Around Towns environmental interventions

FIGURE 27 Intervention site A: site plans for physical improvements. © Crown copyright and database right (2017). Ordnance Survey Licence number [100021242]. Contains public sector information licensed under the Open Government Licence v3.0.

FIGURE 28 Intervention site B: site plans for physical improvements. © Crown copyright and database right (2017). Ordnance Survey Licence number [100021242]. Contains public sector information licensed under the Open Government Licence v3.0.

FIGURE 29 Intervention site C: site plans for physical improvements. © Crown copyright and database right (2017). Ordnance Survey Licence number [100021242]. Contains public sector information licensed under the Open Government Licence v3.0.

Appendix 2 Details of multiple imputation for core survey data

Following Rubin's rules, models were fitted to data with 10 rounds of multiple imputation via chained equations. As reported below, imputation models contained all the covariates, key outcomes, auxiliary variables (e.g. those strongly correlated with dependent variables) and interaction terms.

Because the analysis considered an additional set of secondary outcomes, multiple imputation for each secondary analysis was also carried out. The list of imputed variables, covariates and auxiliary variables reported below was always included in the imputation models. Similarly, for the analyses based on exposure to nature visits, gender and distance bands to the woods, a separate set of multiple imputation was computed. This required including in the imputation models a three-way interaction term instead (type of site × wave × variable of interest).

TABLE 33 Models used to impute variables with missing values

Variable	Model
Age	Ordered logistic regression
Social class	Ordered logistic regression
Highest level of qualification	Ordered logistic regression
Working status	Augmented logistic regression
Income	Ordered logistic regression
Smoking status	Ordered logistic regression
Disability	Logistic regression
Vigorous PA	Predictive mean matching
Moderate PA	Predictive mean matching
Walking	Predictive mean matching
Overall PA	Predictive mean matching
EQ-5D	Predictive mean matching

TABLE 34 Imputed cases by waves

Variable	Case			Total
	Complete	Incomplete	Imputed	
Wave 1				
Age	2113	4	4	2117
Social class	2083	34	34	2117
Highest level of qualification	2115	2	2	2117
Working status	2114	3	3	2117
Income	2049	68	68	2117
Smoking status	2104	13	13	2117
Disability	2108	9	9	2117
Children	2113	4	4	2117
Vigorous PA	2069	48	48	2117
Moderate PA	2051	66	66	2117
Walking	2031	86	86	2117
Overall PA	2024	93	93	2117
EQ-5D	2108	9	9	2117
Wave 2				
Age	1667	5	5	1672
Social class	1626	46	46	1672
Highest level of qualification	1669	3	3	1672
Working status	1670	2	2	1672
Income	1637	35	35	1672
Smoking status	1661	11	11	1672
Disability	1663	9	9	1672
Children	1671	1	1	1672
Vigorous PA	1662	10	10	1672
Moderate PA	1656	16	16	1672
Walking	1659	13	13	1672
Overall PA	1646	26	26	1672
EQ-5D	1668	4	4	1672
Wave 3				
Age	1670	1	1	1671
Social class	1649	22	22	1671
Highest level of qualification	1668	3	3	1671
Working status	1668	3	3	1671
Income	1616	55	55	1671
Smoking status	1658	13	13	1671
Disability	1666	5	5	1671
Children	1668	3	3	1671
Vigorous PA	1659	12	12	1671
Moderate PA	1636	35	35	1671
Walking	1649	22	22	1671
Overall PA	1621	50	50	1671
EQ-5D	1667	4	4	1671

TABLE 34 Imputed cases by waves (*continued*)

Variable	Case			Total
	Complete	Incomplete	Imputed	
Total				
Age	5450	10	10	5460
Social class	5358	102	102	5460
Highest level of qualification	5452	8	8	5460
Working status	5452	8	8	5460
Income	5302	158	158	5460
Smoking status	5423	37	37	5460
Disability	5437	23	23	5460
Children	5452	8	8	5460
Vigorous PA	5390	70	70	5460
Moderate PA	5338	122	122	5460
Walking	5339	121	121	5460
Overall PA	5291	169	169	5460
EQ-5D	5443	17	17	5460

BOX 1 Covariates and auxiliary variables used in the multiple imputation models

Variable
PSS.
SWEMWBS.
Exposure to nature visits.
Gender.
Life events.
Access to car.
Dog ownership.
Health status.
Overall health (EuroQol – visual analogue scales).
Site pair.
Distance band.
Type of site × wave (interaction for difference-in-difference estimate).

Appendix 3 Environmental audit tool and audit results

Environmental audit tool

Have you visited this site before? Y/N
How? (e.g. by foot?)_____

How often?
Visits per month during winter _____
Visits per month during summer _____

Each item below to be scored on a scale of 1 to 5
1 = Poor; 2 = Low; 3 = Medium/Fair; 4 = Good; 5 = Excellent

Location: **Date and time of audit:**

Weather conditions: **Carried out by:**

1 The Neighbourhood	Score	Comments
1.1 Is there a good urban infrastructure (ie. mix of facilities (shops, community centre, recreation), services (police, health, education, public transport), range of housing?		
1.2 How would you rate the appearance of the neighbourhood (e.g. shop frontages/housing/gardens)?		
1.3 Is the neighbourhood free of graffiti, litter, vandalism, dog fouling?		
1.4 Are the local streets/roads well-maintained and well-lit?		
Total Score		
2 Access/signage to Wood		
2.1 Is there good access to the wood e.g. well located entrances, within easy walking distance of homes, accessible by bus?		
2.2 Is there safe access to the woodland e.g. are there safe road crossings (zebras/signals)?		
2.3 Is there a good path network within the woodland (including surface quality, range)?		
2.4 Is it welcoming?		
2.5 Is there equal access for all members of the community? (clear signage, good paths, ramps alongside steps, wide entrances, no obstacles, good seating, accessible information where appropriate)		
2.6 Is there good signage to and within the woodland?		
Total Score		

3 Woodland Quality		
3.1 Is there a variety of spaces within the woodland (e.g. open and enclosed areas)?		
3.2 Is it a rich and stimulating environment?		
3.3 Are the boundaries attractive?		
3.4 Is it high on sensory appeal (presence of water/birds) etc?		
Total Score		
4 Facilities		
4.1 What facilities are present (e.g. presence of toilets, picnic, café, cycle tracks, health/fitness, play, educational, ranger provision)?		
4.2 Do you think these facilities are appropriate to a woodland of this size?		
Total Score		
5 Use		
5.1 Is the space well-used (on the day of audit)?		
5.2 Is there evidence of other use, formal and informal, not present on the day of audit, e.g. remains from picnics, trampling from informal ball games, dens, tyres/swings, ramps, bike tracks etc		
Total Score		
6 Maintenance/Management		
6.1 Is the woodland clean and free from litter, dog fouling and vandalism/graffiti?		
6.2 Are the site furniture and signage and any buildings (if present) well maintained?		
6.3 Is the planting and grass well-maintained?		
6.4 Is there any evidence development within the woodland?		
Total Score		

7 Security/Safety		
7.1 Can you see out from the woodland (to streets/other people)?		
7.2 What's your sense of personal security in the space: • on the day with a group (if appropriate)		
• if you were on your own		
7.3 Is this a secure place for all members of the community to use or walk through (elderly people, people from diverse cultures, children, young people)?		
Total Score		
TOTAL		

TABLE 35 Environmental audit scores for winter visits, intervention and control sites, 2013–15

				Woodland						
Site	Year	Auditor	Neighbourhood quality	Access	Quality	Facilities	Use	Management	Safety	Total (maximum score 35)
Intervention A	2013	Expert	1.5	1.1	1.9	1.3	1.5	1.0	2.2	10.7
	2013	Community	3.3	2.3	2.2	1.7	1.7	1.6	1.9	14.8
	2014	Expert	3.6	3.2	3.5	1.4	3.4	3.7	3.5	22.8
	2014	Community	3.5	3.5	3.3	2.3	1.7	3.0	3.7	21.5
	2015	Expert	3.0	3.5	3.3	2.0	2.3	3.3	2.7	20.5
	2015	Community	3.5	4.1	3.0	2.1	2.3	3.5	3.2	22.2
Intervention B	2013	Expert	2.2	2.2	1.8	1.0	1.5	1.0	2.1	12.1
	2013	Community	2.4	2.8	3.2	1.0	2.2	1.6	3.3	16.8
	2014	Expert	3.0	2.9	2.4	1.2	2.0	3.6	2.7	18.2
	2014	Community	2.6	3.3	3.5	3.5	2.2	3.3	3.2	22.0
	2015	Expert	2.8	3.4	3.3	2.8	3.0	3.3	2.7	21.7
	2015	Community	3.5	3.7	3.9	4.3	2.6	3.2	2.6	24.3
Intervention C	2013	Expert	1.9	1.4	2.2	1.0	2.0	1.0	2.7	12.5
	2013	Community	3.1	2.9	3.6	2.4	2.5	2.3	3.2	20.4
	2014	Expert	2.9	3.7	3.5	1.0	3.8	3.8	3.8	23.0
	2014	Community	3.5	3.9	3.5	2.6	3.1	3.1	3.9	24.0
	2015	Expert	3.2	3.8	3.0	1.5	3.3	3.5	3.5	22.3
	2015	Community	3.0	3.4	3.0	2.0	2.7	2.1	2.9	19.5

Site	Year	Auditor	Neighbourhood quality	Woodland						Total (maximum score 35)
				Access	Quality	Facilities	Use	Management	Safety	
Control A	2013	Expert	2.0	1.1	2.9	1.0	1.5	1.0	2.2	12.0
	2013	Community[a]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	2014	Expert	2.8	1.7	3.4	1.0	1.5	1.2	2.4	14.3
	2014	Community	3.4	3.0	3.8	3.3	3.2	3.5	3.6	24.4
	2015	Expert	2.3	1.7	3.2	1.0	1.5	1.2	2.4	13.5
	2015	Community	3.7	3.5	4.3	2.8	3.8	2.7	4.0	25.3
Control B	2013	Expert	2.8	1.3	1.9	1.0	1.5	1.0	2.0	11.8
	2013	Community	2.7	1.3	1.9	1.2	1.4	1.1	1.6	11.2
	2014	Expert	2.5	1.1	2.3	1.0	1.0	1.0	1.7	10.8
	2014	Community	2.9	1.3	1.8	1.4	1.4	1.0	2.0	11.8
	2015	Expert	2.5	1.4	2.0	1.0	1.8	1.2	2.7	12.8
	2015	Community	3.4	1.3	2.8	1.5	1.3	1.0	2.8	14.3
Control C	2013	Expert	2.2	1.4	2.9	1.0	2.3	1.0	2.3	13.3
	2013	Community	2.9	2.3	2.4	1.4	1.3	1.3	1.6	13.3
	2014	Expert	2.7	1.5	3.0	1.0	2.5	1.2	2.3	14.5
	2014	Community	3.4	2.5	2.4	1.7	2.3	1.9	3.4	18.1
	2015	Expert	2.7	1.5	3.0	1.0	2.5	1.2	2.3	14.5
	2015	Community	3.3	3.0	3.2	2.2	2.4	2.1	3.6	20.2

n/a, not applicable.
a No community members were available and willing to audit control site A in winter 2013.

TABLE 36 Environmental audit scores for summer visits, intervention and control sites, 2013–15

				Woodland (mean)						
Site	Year	Auditor	Neighbourhood quality	Access	Quality	Facilities	Use	Management	Safety	Total (maximum score 35)
Intervention A	2013	Expert	1.8	1.5	2.1	1.0	1.5	1.4	2.4	12.0
	2013	Community	3.6	2.2	3.1	1.3	1.6	1.6	2.3	16.1
	2014	Expert	3.3	3.1	3.2	1.3	2.5	2.2	2.7	18.6
	2014	Community	3.2	3.5	3.5	2.6	2.8	3.2	3.1	22.3
	2015	Expert	1.7	3.2	3.4	2.3	1.8	2.7	2.8	18.1
	2015	Community	3.0	3.8	3.5	2.3	2.3	2.4	2.8	20.6
Intervention B	2013	Expert	3.0	2.3	1.8	1.0	1.8	1.7	2.4	12.0
	2013	Community	2.7	2.9	3.2	2.5	2.8	2.3	2.5	16.1
	2014	Expert	3.3	3.2	3.2	1.5	3.3	3.0	2.5	18.6
	2014	Community	3.5	3.5	4.0	3.7	3.6	4.0	3.4	22.3
	2015	Expert	3.2	3.9	3.7	2.5	3.0	3.2	2.9	18.1
	2015	Community	2.8	4.0	3.6	3.0	4.0	3.3	2.8	20.6
Intervention C	2013	Expert	2.4	1.6	2.8	1.0	2.3	1.5	2.7	14.6
	2013	Community	3.0	2.4	2.6	1.4	2.0	2.1	3.2	16.9
	2014	Expert	3.2	3.0	2.7	1.0	3.0	3.2	3.8	20.3
	2014	Community	3.0	3.2	3.1	2.0	2.8	2.9	2.9	20.4
	2015	Expert	3.0	3.4	3.0	1.0	3.0	2.8	3.2	19.9
	2015	Community	3.3	3.8	3.2	2.1	3.2	2.5	3.4	21.9

Site	Year	Auditor	Neighbourhood quality	Woodland (mean)						Total (maximum score 35)
				Access	Quality	Facilities	Use	Management	Safety	
Control A	2013	Expert	2.2	1.4	2.5	1.0	1.3	1.2	2.3	12.1
	2013	Community	2.7	2.3	3.0	1.9	2.4	1.5	2.0	16.1
	2014	Expert	2.8	1.7	3.4	1.0	2.0	1.4	2.0	14.6
	2014	Community	3.5	3.2	3.9	2.7	3.0	3.3	3.4	23.5
	2015	Expert	2.9	1.6	3.4	1.0	1.3	1.5	2.2	14.2
	2015	Community	3.3	2.0	3.5	0.5	2.0	0.5	1.8	13.6
Control B	2013	Expert	2.7	1.3	3.0	1.0	2.0	1.0	2.3	13.6
	2013	Community	2.8	1.5	2.4	1.2	1.8	1.4	1.6	12.9
	2014	Expert	2.8	1.4	2.0	1.0	2.3	1.4	2.3	13.4
	2014	Community	3.5	1.9	2.6	1.3	2.2	1.3	1.5	14.5
	2015	Expert	2.2	1.4	1.9	1.0	1.0	1.3	2.4	11.4
	2015	Community	2.3	1.2	2.0	1.0	1.0	1.0	1.7	10.4
Control C	2013	Expert	2.4	1.6	2.9	1.0	1.5	1.2	1.7	12.6
	2013	Community	3.0	3.1	3.1	1.5	2.1	1.6	2.2	16.9
	2014	Expert	3.7	2.4	2.9	1.0	2.3	1.2	2.5	16.3
	2014	Community	3.1	3.2	2.7	2.3	2.5	2.0	3.2	19.3
	2015	Expert	2.9	2.4	3.3	1.0	2.8	1.2	2.4	16.3
	2015	Community	2.9	2.6	2.5	1.5	2.2	2.0	2.4	16.4

BOX 2 Summary of written comments by community auditors for intervention site A audits, winter and summer, 2013–15

Intervention site A

Winter 2013: baseline

Neighbourhood

'Very handy for all facilities.' (Neighbourhood facilities.)

'Quite good.' (Neighbourhood appearance.)

'Quite bad.' (Litter, vandalism, dog fouling.)

Access and signage

'Very bad entrance. Bad litter lying around.' (Access to the woodland.)

Use

'Only a dog walker.' (Use on the day of the audit.)

Summer 2013

Neighbourhood

'Near buses/housing good near community centre and clinic.' (Neighbourhood infrastructures.)

'Decent area.' (Neighbourhood appearance.)

'No too bad.' (Litter, vandalism, dog fouling – gave a score of 3.)

Access and signage

'No signage. Not well known if you do not live in the area.' (Access to the woodland.)

'Only our knowledge of where the entrance is [lets us gain access to the woodland] but bus access is good.' (Access to the woodland.)

'If you live in this area, visitors would be lost.' (Access to the woodland.)

'Not good for groups. No structures, paths.' (Equal access.)

'Need paths cleared.' (Path network.)

'No signage'; 'need more signage on the main road.' (Signage.)

'Could be better.' (Welcoming.)

BOX 2 Summary of written comments by community auditors for intervention site A audits, winter and summer, 2013–15 (*continued*)

Woodland quality

'Some attractive'; 'some attractive, some not.' (Boundaries.)

'Meadow lovely and trees.' (Variety of spaces.)

'Very good.' (Sensory appeal.)

Facilities

'None at all.' (Facilities – present.)

'Woodlands be more useful for some. Seating in certain areas.' (Facilities – appropriate.)

'Not applicable.' (Furniture.)

Use

'Only a dog walker.' (Use on the day of the audit.)

'The paths were well used.' (Evidence of use.)

'None at all.' (Evidence of use.)

'Dog walkers/teenage groups vandalising flat area.' (Evidence of use.)

'Does not seem much except a fire and track.' (Evidence of use.)

Management

'Wild.' (Planting and grass well maintained.)

'None.' (Evidence of development.)

'Could be better.' (Woodland is free from litter, dog fouling and vandalism/graffiti.)

Safety

'Quite good.'(See out of woodlands.)

'Can see out from certain areas.' (See out of woodlands.)

'In a group OK.' (Safety with the group.)

'With the group I feel safe but I still couldn't be wary coming alone.' (Safety with the group.)

'No.' (Safety if alone.)

'Would be wary on my own.' (Safety if alone.)

'Wouldn't advise for elderly.' (Secure place for all members of the community.)

'Too isolated.' (Secure place for all members of the community.)

BOX 2 Summary of written comments by community auditors for intervention site A audits, winter and summer, 2013–15 (*continued*)

Winter 2014

Neighbourhood

'Good local infrastructure, variety of housing, etc.' (Neighbourhood infrastructure.)

'Only housing in this part.' (Neighbourhood infrastructure.)

'Very impress with work done. The paths are good and wide.' (Neighbourhood infrastructure.)

'No shops in this part of the area.' (Neighbourhood appearance.)

'Good.' (Neighbourhood appearance.)

'Fine – pleasant.' (Neighbourhood appearance.)

'Neighbourhood will be pleased with the woodland.' (Neighbourhood appearance.)

'Much better.' (Litter, vandalism, dog fouling.)

'Some litter.' (Litter, vandalism, dog fouling.)

'Lots of litter.' (Litter, vandalism, dog fouling.)

'Never seen much.' (Litter, vandalism, dog fouling.)

'Pavement edges, verges still flooding.' (Streets maintained.)

'Roads are quite good.' (Streets maintained.)

Access and signage

'Only entrance is what is missing.' (Access to the woodland.)

'No zebra [crossings] or bus access. Access by walking.' (Access to the woodland.)

'No signs. Could be more signs on the main road.' (Access to the woodland.)

'Brilliant!' (Path network.)

'Very good paths, surface good.' (Path network.)

'Big improvement now with paths, picnic area, benches, etc.' (Equal access.)

'Except signage. The surface is suitable for all abilities of walkers.' (Equal access.)

'No signage.' (Signage.)

'This needs to be improved.' (Signage.)

BOX 2 Summary of written comments by community auditors for intervention site A audits, winter and summer, 2013–15 (*continued*)

Woodland quality

'Pleasant area – in winter it's quiet.' (Variety of spaces.)

'Much better than before – we could picnic here.' (Variety of spaces.)

'Definitely.' (Stimulating environment.)

'Still a bit quiet, unless walking in a group.' (Stimulating environment.)

Facilities

'New seats all around.' (Facilities.)

'Cycle paths, no toilets, no café. Good for walking groups and school walks.' (Facilities.)

'Some would be appropriate (e.g. toilets).' (Facilities appropriate.)

Use

'One cyclist only.' (Use on the day of the audit.)

'Passed one person.' (Use on the day of the audit.)

Management

'Lots of litter.' (Litter.)

'A few seats.' (Furniture.)

'New paths and picnic area.' (Evidence of development.)

Safety

'Certain parts have new views after change of path route.' (See out of woodlands.)

'I felt safer than the last time.' (Personal security – group.)

'Not in winter – too quiet.' (Personal security alone.)

'It's easy if you take your time.' (Secure place for all.)

'Too quiet for walks.' (Secure place for all.)

Summer 2014

Neighbourhood

'Short walk to the shops.' (Neighbourhood infrastructures.)

'Roads a bit untidy and grass needs tidying up.' (Neighbourhood appearance.)

'Too much dog fouling.' (Litter, vandalism, dog fouling.)

BOX 2 Summary of written comments by community auditors for intervention site A audits, winter and summer, 2013–15 (*continued*)

Access and signage

'More seating to encourage local people to sit out on a sunny day.' (Equal access.)

Woodland quality

'Could be cut back to have a view.' (Boundaries.)

Facilities

'We have none of these facilities here except picnic tables.' (Facilities – present.)

'No facilities. Bike tracks not needed.' (Facilities – present.)

'Only tables.' (Facilities – present.)

'Yes.' (Facilities – appropriate.)

Use

'Yes, came across litter left behind.' (Evidence of use.)

'Garbage about. No bike tracks, no ball games, which is fine. Cycles would be dangerous (I am cyclist myself).' (Evidence of use.)

Management

'Garbage and empty beer and wine bottle in ditch.' (Woodland is free from litter, dog fouling and vandalism/graffiti.)

'So far.' (Furniture.)

'Wonderful and path well defined.' (Planting and grass well maintained.)

'Could do with flower bulbs.' (Planting and grass well maintained.)

'Lots of work done since last time.' (Evidence of development.)

Safety

'Quite good.' (See out of woodlands.)

'Can see out from certain areas.' (See out of woodlands.)

'In a group OK'; 'with the group I feel safe but I'd still be wary coming alone.' (Safety with the group.)

'No.' (Safety if alone.)

'Would be wary on my own.' (Safety if alone.)

'Wouldn't advise for elderly.' (Secure place for all members of the community.)

'Too isolated.' (Secure place for all members of the community.)

BOX 2 Summary of written comments by community auditors for intervention site A audits, winter and summer, 2013–15 (*continued*)

Winter 2015

Access and signage

'Good network surface but it could do with more pathways.' (Path network.)

'Didn't see any ramps for disabled people in wheelchairs.' (Equal access.)

Woodland quality

'It is better in the summer.' (Sensory appeal.)

'It was a lot cleaner than the last walk.' (Woodland free from litter.)

Management

'Sculpture made of wood added.' (Evidence of development.)

Safety

'Limited views.' (See out of woodlands.)

Summer 2015

Access and signage

'Good.' (Access.)

'Not too bad. Could be better.' (Equal access.)

Woodland quality

'Yes, lots of foliage/trees/birds.' (Stimulating environment.)

Management

'Could be more seats.' (Furniture.)

Safety

'Unfortunately vandalism has taken place on the woodlands sculpture, which was burned.' (Evidence of other use.)

'Not sure.' (Safety on their own.)

'With group fine.' (Safety with the group.)

BOX 3 Summary of written comments by community auditors for control site A audits, winter and summer, 2013–15

Control site A

Winter 2013: baseline

No audit conducted. (Lack of community participants.)

Summer 2013

Neighbourhood

'[The town] as a whole would score higher than this area. Compared with other areas in [region] is poorly served.' (Neighbourhood infrastructures.)

'Score based on facilities of [the] town centre about 1–2 miles away.' (Neighbourhood infrastructures – participant gave a score of 4.)

Use

'Drinkers' den.' (Evidence of use.)

Management

'Some evidence of maintenance of sewage system.' (Evidence of development.)

Winter 2014

Neighbourhood

'Lots of houses round about, but not many facilities.' (Neighbourhood infrastructure.)

'Nice houses – we can see more of them at this time of year.' (Neighbourhood appearance.)

'Could be cleaner.' (Litter, vandalism, dog fouling.)

'Lots of litter and I doubt the council ever clear up here.' (Litter, vandalism, dog fouling.)

Access and signage

'Easy access where the wire-strand fence has been broken down!' (Access to the woodland.)

'More signs.' (Access to the woodland.)

'A path exists but is muddy and of broken quality in parts.' (Path network.)

'Needs work.' (Path network.)

'Not particularly!' (Welcoming.)

'So, so. If sunny, yes.' (Welcoming.)

'No access at all if you are physically disadvantaged.' (Equal access.)

'Needs some work done on the paths.' (Equal access.)

'None at all.' (Signage.)

BOX 3 Summary of written comments by community auditors for control site A audits, winter and summer, 2013–15 (*continued*)

Woodland quality

'Could be better.' (Variety of spaces.)

'Nice.' (Rich and stimulating environment.)

'Lots of water sounds. Birds absent today – due to wind?' (Sensory appeal.)

Facilities

'No facilities at all.' (Facilities.)

Use

'No-one but the audit.' (Use on the day of the audit.)

'Too wet and windy.' (Use on the day of the audit.)

'Kids still use it now and again.' (Evidence of use.)

'Plenty of litter as evidence – also remains of a fire.' (Evidence of use.)

Safety

'Yes, when trees not in leaf.' (See out from the woodland.)

'OK when with a group – very close to road.' (Personal security – group.)

'Wouldn't want to be here alone!' (Personal security alone.)

'Only in groups.' (Secure place for all.)

'Need paths and signs.' (Secure place for all.)

Summer 2014

Neighbourhood

'Bus services could be better.' (Neighbourhood infrastructures.)

'Too much rubbish on streets.' (Neighbourhood appearance.)

'Not good.' (Neighbourhood litter, graffiti.)

Access and signage

'Few minutes' walk from the house.' (Woodland's good access.)

'No signs, ramp, etc.' (Woodland's equal access.)

BOX 3 Summary of written comments by community auditors for control site A audits, winter and summer, 2013–15 (*continued*)

Woodland quality

'Very good wild life.' (Woodland's sensory appeal.)

'River, trees and lots of native plants.' (Woodland's rich and stimulating environment.)

Use

'Lots of fire sites, lots of litter including broken bottles.' (Evidence of use.)

Management

'No.' (Evidence of development.)

Winter 2015

No comments.

Summer 2015

Neighbourhood

'[The town] has all these amenities, but not necessarily close to this particular woodland, which is at the edge of town.'

BOX 4 Summary of written comments by community auditors for intervention site B audits, winter and summer, 2013–15

Intervention site B

Winter 2013: baseline

Neighbourhood

'Dog fouling is a big problem.' (Litter, vandalism, dog fouling.)

Summer 2013

Neighbourhood

'No community centre. Needs more shops'. (Neighbourhood infrastructure.)

'New sports facilities in April 2013, new housing 2012. Area improving.' (Neighbourhood infrastructure.)

'Community centre was demolished. Tesco had plans to build in [town] but this has yet to happen. No police base, new housing. So this is on the rise.' (Neighbourhood infrastructure.)

'Has improved but could still be a lot better.' (Neighbourhood infrastructure.)

BOX 4 Summary of written comments by community auditors for intervention site B audits, winter and summer, 2013–15 (*continued*)

'Is improving with regeneration.' (Neighbourhood infrastructure.)

'More street sweepers needed.' (Neighbourhood's appearance.)

'Everyone – most have pride in their immediate area.' (Neighbourhood's appearance.)

'Dog fouling is a huge problem.' (Litter, vandalism, dog fouling.)

'Dog mess everywhere, litter also – broken glass.' (Litter, vandalism, dog fouling.)

'Litter and dog fouling all over.' (Litter, vandalism, dog fouling.)

'Pavements bad.' (Litter, vandalism, dog fouling.)

'Poor paving.' (Litter, vandalism, dog fouling.)

Access and signage

'Needs to be improved.' (Path network.)

'Overgrown and muddy.' (Path network.)

'Not suitable for wheelchair users.' (Equal access.)

'Outdated/not readable.' (Signs.)

Woodland quality

'Outgrown area.' (Boundaries.)

'No. Landfill nearby plus fly tipping on road.' (Boundaries.)

Facilities

'The [sports centre] nearby.' (Facilities.)

'Only the sports centre.' (Facilities.)

Use

'No.' (Well used on the day of the audit.)

'Has no activities.' (Evidence of use.)

Management

'The whole area needs to be improved.' (Woodland litter.)

'Dog mess.' (Woodland litter.)

BOX 4 Summary of written comments by community auditors for intervention site B audits, winter and summer, 2013–15 (*continued*)

Safety

'No.' (Safe place for all members of the community.)

Winter 2014

Neighbourhood

'The area is improving.' (Neighbourhood infrastructure.)

'Still dog fouling on the pathways.' (Litter, vandalism, dog fouling.)

Access and signage

'Much better than it was.' (Path network.)

'No signage at all.' (Signage.)

Management

'New benches, no signs.' (Site furniture and signage.)

Summer 2014

Neighbourhood

'Could do with more private housing.' (Neighbourhood infrastructure.)

'Getting better with Tesco site. Still progress to be made.' (Neighbourhood infrastructure.)

'Because of the regeneration all the facilities are really good and continue to improve.' (Neighbourhood infrastructure.)

'Again, everything is improving.' (Neighbourhood's appearance.)

'Dog fouling still a problem. Vandalism is better.' (Litter, vandalism, dog fouling.)

'Some dog fouling. (Litter, vandalism, dog fouling.)

'Grass cutting is a disgrace.' (Local streets well lit/maintained.)

Access and signage

'Paths from the fields could be better.' (Good access.)

'The entrances should be made clear.' (Good access.)

'The bits that have been upgraded are good.' (Path network.)

'Poor for prams and wheelchairs.' (Equal access.)

'No map or description of the woodlands.' (Signage.)

'No.' (Signage.)

'There is virtually no signage.' (Signage.)

BOX 4 Summary of written comments by community auditors for intervention site B audits, winter and summer, 2013–15 (*continued*)

Woodland quality

'Another open area for picnics.' (Variety of spaces.)

'Development still in progress.' (Boundaries.)

'Lovely deer.' (Stimulating.)

Facilities

'No outdoor fitness for adults.' (Facilities present.)

'Facilities at the [sports centre] only.' (Facilities present.)

'Picnic tables available. Toilets in sports centre fairly close.' (Facilities present.)

'I would like to see more picnic area and rangers' activities.' (Facilities present.)

Use

'Informal campfire.' (Evidence of other use.)

'Lots of rubbish, broken glass.' (Evidence of other use.)

Management

'Dog fouling.' (Clean.)

'Some graffiti.' (Clean.)

'Furniture is well maintained. There is no signage.' (Site furniture and signage.)

'No signage as to routes.' (Site furniture and signage.)

'New pathways, new jetty at pond, new picnic benches.' (Evidence of development.)

Winter 2015

Neighbourhood

'Got better.' (Neighbourhood infrastructure.)

'Massive improvements.' (Appearance of the neighbourhood.)

Access and signage

'Paths could have better surface when wet are very muddy.' (Woodland access.)

Management

'Fly tipping and dog fouling.' (Litter, dog fouling.)

'Broken picnic tables.' (Site furniture.)

BOX 4 Summary of written comments by community auditors for intervention site B audits, winter and summer, 2013–15 (*continued*)

Safety

'OK with the group.' (Safety with the group.)

'Not keen (if alone).' (Personal security alone.)

Summer 2015

Neighbourhood

'Due to regeneration, this [infrastructure] has improved.' (Neighbourhood infrastructure.)

Management

'More maintenance needed.' (Maintenance.)

'Burnt table.' (Site furniture.)

BOX 5 Summary of written comments by community auditors for control site B audits, winter and summer, 2013–15

Control site B

Winter 2013: baseline

Neighbourhood

'Nothing for lads to do in the area.' (Neighbourhood infrastructure.)

'Area needs better facilities. Not one playground for the children.' (Neighbourhood infrastructure.)

'I think the surrounding area is good. In there, there is a library, shops, schools.' (Neighbourhood infrastructure.)

'Most houses are well maintained. Not different from the surrounding areas.' (Neighbourhood appearance.)

'Very poor in some parts.' (Neighbourhood appearance.)

'Too much fouling.' (Litter, vandalism, dog fouling.)

'There is evidence of fouling.' (Litter, vandalism, dog fouling.)

Access and signage

'No. The wood is overgrown and not maintained.' (Good and safe access.)

'Very poor access points.' (Good and safe access.)

BOX 5 Summary of written comments by community auditors for control site B audits, winter and summer, 2013–15 (*continued*)

'No management of the woodlands for 20 years.' (Good and safe access.)

'Basic.' (Path network.)

'No, overgrown.' (Path network.)

'No clear routes.' (Path network.)

'No, it is steep and no exit or entrances are clear.' (Welcoming.)

'No, more like a wasteland.' (Welcoming.)

'No way anyone with disabilities could access the wood area.' (Equal access.)

'Very overgrown, you would not know it was here.' (Equal access.)

'No seating, no wheelchair access.' (Equal access.)

Woodland quality

'Yes, due to tree density.' (Variety of spaces.)

'No.' (Variety of spaces.)

'Could be a great place if sorted.' (Variety of spaces.)

'Potentially, with management.' (Rich and stimulating.)

'Definitely not.' (Rich and stimulating.)

Facilities

'None.' (Facilities present.)

Use

'Yes, dams and areas that used to be well used.' (Evidence of other use.)

'Used as a dumping ground.' (Evidence of other use.)

Management

'None in it. Not friendly.' (Written on the last page, across various categories.)

Safety

'Because we were as a group.' (Safety with the group – gave a score of 2.)

'Never.' (Access if you were on your own.)

BOX 5 Summary of written comments by community auditors for control site B audits, winter and summer, 2013–15 (*continued*)

Summer 2013

Neighbourhood

'Could do with a café. The one that was there closed a few years ago.' (Neighbourhood infrastructure.)

'No police station, no health visitors for the area. Now you need to go to [another town in area] to access the baby clinic.' (Neighbourhood infrastructure.)

'Some are lovely.' (Neighbourhood appearance.)

'Lots of dog fouling.' (Litter, vandalism, dog fouling.)

Access and signage

'The local authority should make pathways.' (Path network.)

'Stairs falling apart.' (Path network.)

Woodland quality

'Overgrown weeds and trees.' (Boundaries.)

Facilities

'There is nothing letting the public know the area exists.' (Facilities appropriate for the size.)

Use

'Dens used by kids at night.' (Evidence of other use.)

'Fires, dens, tyre swings, old prams, rubbish.' (Evidence of other use.)

Management

'Overgrown.' (Maintenance.)

'The steps are falling apart.' (Development within the woodland.)

Safety

'Very dangerous.' (Access if you were on your own.)

'No elderly people could use the area, it's too overgrown and dangerous. Children could play here.' (Access for the community.)

BOX 5 Summary of written comments by community auditors for control site B audits, winter and summer, 2013–15 (*continued*)

Winter 2014

Neighbourhood

'Access to the community centre is limited.' (Neighbourhood infrastructure.)

'Some great, though a few uncared for.' (Neighbourhood appearance.)

'Lots of dog fouling and litter in the woodland area.' (Litter, vandalism, dog fouling.)

'Dog fouling along a lot of the route.' (Litter, vandalism, dog fouling.)

Access and signage

'No, quite intimidating.' (Welcoming.)

'Litter puts me off.' (Welcoming.)

'Paths that have been trodden in.' (Path network.)

'No. Have to be able bodied.' (Equal access.)

'No signs or ramps.' (Equal access.)

Facilities

'No play facilities for pre-school children or teenagers in [the town] at all.' (Facilities present.)

Use

'By people as a dumping site.' (Used on day.)

'Poorly trodden paths so it is used but don't know by whom.' (Evidence of other use.)

Summer 2014

Neighbourhood

'Very poor in some parts.' (Neighbourhood appearance.)

'Much fouling.' (Litter, vandalism, dog fouling.)

Access and signage

'No management of the woodlands for 20 years.' (Good and safe access.)

'No, overgrown.' (Path network.)

'No routes.' (Path network.)

BOX 5 Summary of written comments by community auditors for control site B audits, winter and summer, 2013–15 (*continued*)

Facilities

'None.' (Facilities.)

Use

'Litter.' (Evidence of other use.)

Winter 2015

No comments.

Summer 2015

Neighbourhood

'Very poor.' (Neighbourhood infrastructure.)

'Terrible.' (Neighbourhood infrastructure.)

'Neglected.' (Neighbourhood appearance.)

'Embarrassing.' (Litter, vandalism, dog fouling.)

Access and signage

'The local authority should make pathways.' (Woodland access.)

'No.' (Woodland access.)

'Nothing.' (Equal access.)

Woodland quality

'Very little due to the overgrown woodland and litter.' (Variety of spaces.)

Use

'Vast amount of litter.' (Woodland use.)

'Dumping.' (Woodland use.)

BOX 6 Summary of written comments by community auditors for intervention site C audits, winter and summer, 2013–15

Intervention site C

Winter 2013: baseline

Neighbourhood

'About to change.' (Neighbourhood infrastructure.)

'A lot of older flats and houses look run down.' (Neighbourhood infrastructure.)

'A lot of older looking and worn shops.' (Neighbourhood appearance.)

'A lot of dog dirt.' (Neighbourhood dog fouling, vandalism, graffiti, litter.)

'This is not a problem.' (Street maintenance.)

Access and signage

'No zebra or pelican crossing to entrances.' (Good and safe access.)

'No visible paths at all.' (Path network.)

'Signage could be improved and no disabled access.' (Equal access.)

Woodland quality

'Good open wood.' (Variety of spaces.)

'Views are good.' (Stimulating.)

'Basic planting.' (Boundaries.)

'Plenty of wildlife.' (Sensory appeal.)

Facilities

'No benches or toilets.' (Facilities.)

'No, not a lot.' (Facilities.)

'No facilities.' (Appropriate facilities.)

Use

'Only two dog walkers.' (Use.)

'Plenty of dumping.' (Evidence of other use.)

'Bike tracks.' (Evidence of other use.)

BOX 6 Summary of written comments by community auditors for intervention site C audits, winter and summer, 2013–15 (*continued*)

Management

'Lots of dog dirt and waste.' (Litter.)

'No.' (Evidence of development.)

Safety

'Not good for wheelchairs.' (Safe for all members of the community.)

Summer 2013

Neighbourhood

'Needs a good clear out.' (Neighbourhood infrastructure.)

'A lot of older flats and houses look run down.' (Neighbourhood infrastructure.)

'Could improve.' (Neighbourhood appearance.)

'Not too bad.' (Neighbourhood dog fouling, vandalism, graffiti, litter.)

'No way.' (Neighbourhood dog fouling, vandalism, graffiti, litter.)

'Reasonable.' (Street maintenance.)

'Paths not well lit.' (Street maintenance.)

Access and signage

'None existing at the moment.' (Path network.)

'No disabled access.' (Equal access.)

'No access for older people.' (Equal access.)

'None.' (Signage.)

Woodland quality

'Poor at present.' (Variety of spaces.)

'Overgrown.' (Stimulating.)

'Well kept boundaries.' (Boundaries.)

'None at the present.' (Boundaries.)

'No water or visible wildlife.' (Sensory appeal.)

BOX 6 Summary of written comments by community auditors for intervention site C audits, winter and summer, 2013–15 (*continued*)

Facilities

'No facilities.' (Facilities.)

'Poor at present.' (Facilities.)

'No. Vandals would attack it.' (Appropriate facilities.)

Use

'Reasonably used.' (Use.)

'Evidence of fire.' (Evidence of other use.)

'Tracks overgrown, dinking bottles and gas cans.' (Evidence of other use.)

'Leftover rubbish plus waste.' (Evidence of other use.)

Management

'Dog fouling and fly tipping.' (Litter.)

'No furniture.' (Furniture.)

'Could all be cut back.' (Planting.)

'No.' (Evidence of development.)

Safety

'Good.' (Sense of personal safety with the group.)

'No disabled access.' (Safe for all members of the community.)

Winter 2014

Neighbourhood

'Limited shopping facilities. Doubt over community centre as new campus being built.' (Neighbourhood infrastructure.)

'Shopping centre looking a bit tired. Housing vastly improved with new cladding, etc.' (Neighbourhood appearance.)

'Graffiti and dog fouling evident. Fly tipping in the woodland.' (Neighbourhood dog fouling, vandalism, graffiti, litter.)

'Roads and pavements needing a bit of attention.' (Street maintenance.)

BOX 6 Summary of written comments by community auditors for intervention site C audits, winter and summer, 2013–15 (*continued*)

Access and signage

'A lot better to walk through.' (Path network.)

'There is no signage.' (Equal access.)

Woodland quality

'Will be better with time.' (Boundaries.)

Facilities

'No toilets.' (Facilities.)

'There could be a bit more.' (Appropriate facilities.)

Use

'Quad bikes and motorbikes using the tracks.' (Evidence of other use.)

'Dumping of rubbish.' (Evidence of other use.)

Management

'Dog fouling on the path.' (Litter.)

'Still developing.' (Planting maintained.)

Safety

'Wouldn't come on own at night.' (Safety when alone.)

Summer 2014

Neighbourhood

'A lot of dog dirt.' (Neighbourhood dog fouling, vandalism, graffiti, litter.)

Woodland quality

'Plenty of wildlife.' (Sensory appeal.)

Facilities

'No, not a lot.' (Facilities.)

Safety

'Not good for wheelchairs.' (Safe for all members of the community.)

BOX 6 Summary of written comments by community auditors for intervention site C audits, winter and summer, 2013–15 (*continued*)

Winter 2015

No comments.

Summer 2015

Neighbourhood

'Litter/dog fouling.' (Litter, dog fouling.)

'Unfortunately there is still a lot of fouling on the path.' (Dog fouling.)

Access and signage

'Very much improved.' (Welcoming.)

'First class.' (Path network)

Use

'Dog with walkers.' (Use.)

Management

'Very good.' (Woodland clean.)

Safety

'Much improved.' (Personal security.)

BOX 7 Summary of written comments by community auditors for control site C audits, winter and summer, 2013–15

Control site C

Winter 2013: baseline

Neighbourhood

'Good.' (Neighbourhood appearance.)

'Lots of litter, etc.' (Neighbourhood litter, vandalism, dog fouling.)

'Reasonable.' (Street maintenance.)

BOX 7 Summary of written comments by community auditors for control site C audits, winter and summer, 2013–15 (*continued*)

Access and signage

'Reasonable.' (Good and safe access.)

'Not too bad.' (Good and safe access.)

'Not really.' (Path network.)

'Fair.' (Path network.)

'Not too bad.' (Welcoming.)

'No, more like a wasteland.' (Welcoming.)

'No ramps.' (Equal access.)

'Access could be difficult.' (Equal access.)

'None.' (Signage.)

Woodland quality

'Average.' (Variety of spaces.)

Facilities

'None.' (Facilities.)

Summer 2013

Neighbourhood

'Good place to walk.' (Neighbourhood infrastructure.)

'Good.' (Neighbourhood appearance.)

'Lots of litter.' (Neighbourhood litter, vandalism, dog fouling.)

'Reasonable.' (Street maintenance.)

Access and signage

'Quite welcoming.' (Welcoming.)

'No signage.' (Signage.)

Woodland quality

'So so.' (Rich and stimulating.)

BOX 7 Summary of written comments by community auditors for control site C audits, winter and summer, 2013–15 (*continued*)

Facilities

'None.' (Facilities.)

Management

'Too much litter on the paths.' (Cleanliness.)

Winter 2014

Neighbourhood

'Reasonable.' (Neighbourhood infrastructure.)

'Quite good.' (Neighbourhood appearance.)

'Sometimes.' (Street maintenance.)

Access and signage

'Sometimes if there isn't heavy rain.' (Path network.)

'Sometimes.' (Welcoming.)

Woodland quality

'Not really.' (Variety of spaces.)

'Not really.' (Boundaries.)

'Sometimes hear lots of birds.' (Sensory appeal.)

Facilities

'None.' (Facilities.)

'No cafés or picnic areas.' (Facilities.)

Use

'Bike tracks.' (Evidence of use.)

Management

'See so much litter.' (Litter.)

'None.' (Evidence of development.)

BOX 7 Summary of written comments by community auditors for control site C audits, winter and summer, 2013–15 (*continued*)

Summer 2014

Neighbourhood

'Good.' (Neighbourhood appearance.)

'Lots of litter, etc.' (Neighbourhood litter, vandalism, dog fouling.)

Access and signage

'Not too bad.' (Good and safe access.)

'No ramps.' (Equal access.)

'None.' (Signage.)

Woodland quality

'Average.' (Variety of spaces.)

Facilities

'None.' (Facilities.)

Winter 2015

Woodland quality

'Could hear the birds singing.' (Sensory appeal.)

Use

'See more tracks.' (Woodland use.)

Management

'See so much litter.' (Litter.)

'None.' (Evidence of development.)

Summer 2015

No comments.

Appendix 4 Core survey data: characteristics of participants at waves 2 and 3

TABLE 37 Characteristics of participants at wave 2: panel A (cross-sectional sample) (imputed data)

Variable	Site (%)		Total (%) ($N = 1672$)	p-value for test of difference[a]
	Intervention ($n = 750$)	Control ($n = 93$)		
Age (years)				
16–24	8.2	7.7	7.9	0.70
25–34	15.9	16.6	16.3	0.74
35–44	14.2	14.4	14.3	0.91
45–54	20.3	18.1	19.1	0.26
55–64	13	16.1	14.7	0.07
65–74	12.7	14.9	13.9	0.19
≥ 75	15.5	12.1	13.6	0.05
Gender				
Female	59.7	57.6	58.6	0.38
Male	40.3	42.4	41.4	0.38
Life events				
Better than normal	4.1	6.9	5.6	**0.01**
Much worse than normal	9.1	10.3	9.7	0.39
No different than normal	29.7	19.8	23.6	**< 0.001**
Nothing has happened in last 12 months	57.2	64.1	61.0	**0.004**
Social class[b]				
I	2.3	4.2	3.3	**0.03**
II	17.0	18.9	18.1	0.34
III	14.6	18.7	16.9	**0.03**
IV	21.3	25.0	23.4	0.08
V	44.7	33.2	38.3	**< 0.001**
Highest level of qualification[c]				
No qualification	45.1	27.6	35.4	**< 0.001**
1	28.7	44.0	37.2	**< 0.001**
2	15.4	11.0	12.9	**0.008**
3	5.7	10.0	8.1	**< 0.001**
4	5.1	7.4	6.4	0.05
Working status				
No	60.3	55.1	57.4	**0.03**
Yes	39.7	45.0	42.6	**0.03**

continued

TABLE 37 Characteristics of participants at wave 2: panel A (cross-sectional sample) (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 1672$)	*p*-value for test of difference[a]
	Intervention ($n = 750$)	Control ($n = 93$)		
Income coping				
Finding it difficult on present income	27.6	15.3	20.8	**< 0.001**
Coping on present income	54.3	50.8	52.4	0.16
Living comfortably on present income	18.1	33.9	26.9	**< 0.001**
Distance to woods (m)				
≤ 150	6.1	29.8	19.3	**< 0.001**
151–300	11.1	23.9	18.2	**< 0.001**
301–500	22.3	18.9	20.4	0.08
501–750	23.4	19.5	21.2	0.06
751–1500	37.2	7.8	20.8	**< 0.001**
Access to a car				
No	48.8	36.9	42.2	**< 0.001**
Yes	51.2	63.1	57.8	**< 0.001**
Smoking status				
Currently smoke	33.7	25.3	29.1	**< 0.001**
Smoked in the past	22.4	19.6	20.9	0.16
Never smoked	43.8	55.1	50.1	**< 0.001**
Disability				
No	88.3	88.7	88.5	0.80
Yes	11.7	11.3	11.5	0.80
Health limited				
Yes, limited a lot	13.5	12.4	12.9	0.52
Yes, limited a little	15.5	14.4	14.9	0.51
No, not limited at all	70.9	73.2	72.2	0.31
Dog ownership				
No	80.8	72.7	76.3	**< 0.001**
Yes	19.1	27.2	23.7	**< 0.001**
Children in household				
No	73.8	73.6	73.7	0.92
Yes	26.2	26.4	26.3	0.92
Site pair				
A	11.8	36.6	25.6	**< 0.001**
B	49.1	25.6	36.0	**< 0.001**
C	39.2	37.8	38.4	0.55

a *p*-values < 0.05 indicated in bold.
b Based on occupational categories, where I = highest grade occupations; V = state pensioners, unemployed or lowest grade occupations.
c Levels range from 1 (school leaver qualifications: O grade, standard grade or equivalent) to 4 (higher education qualifications: first degree or higher).

TABLE 38 Characteristics of participants at wave 3: panel A (cross-sectional sample) (imputed data)

Variable	Site (%)		Total (%) ($N = 1671$)	p-value for test of difference[a]
	Intervention ($n = 816$)	Control ($n = 855$)		
Age (years)				
16–24	8.0	7.3	7.6	0.58
25–34	14.9	15.8	15.4	0.63
35–44	12.6	17.5	15.1	**0.005**
45–54	17.8	16.5	17.1	0.49
55–64	15.2	15.0	15.1	0.90
65–74	15.0	14.9	14.9	0.97
≥ 75	16.5	13	14.7	**0.04**
Gender				
Female	62.5	61.3	61.9	0.61
Male	37.5	38.7	38.1	0.61
Life events				
Better than normal	3.4	6.1	4.8	**0.01**
Much worse than normal	13.4	14.3	13.8	0.59
No different than normal	45.2	30.5	37.7	**< 0.001**
Nothing has happened in last 12 months	38.0	49.1	43.7	**< 0.001**
Social class[b]				
I	4.2	5.7	5.0	0.17
II	18.5	18.2	18.4	0.83
III	15.4	16.4	15.9	0.57
IV	20.5	22.6	21.6	0.30
V	41.3	37.1	39.2	0.08
Highest level of qualification[c]				
No qualification	45.5	31.6	38.4	**< 0.001**
1	24.9	31.6	28.3	**0.002**
2	16.2	14.7	15.4	0.42
3	7.4	12.1	9.7	**0.001**
4	6.1	10.0	8.1	**0.004**
Working status				
No	62.8	57.5	60.1	**0.03**
Yes	37.2	42.4	39.9	**0.03**
Income coping				
Finding it difficult on present income	21.5	14.9	18.1	**< 0.001**
Coping on present income	52.4	54.2	53.3	0.46
Living comfortably on present income	26.1	30.9	28.6	**0.03**

continued

TABLE 38 Characteristics of participants at wave 3: panel A (cross-sectional sample) (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 1671$)	*p*-value for test of difference[a]
	Intervention ($n = 816$)	Control ($n = 855$)		
Distance to woods (m)				
≤ 150	9.4	29.7	19.8	**< 0.001**
151–300	13.0	26.3	19.8	**< 0.001**
301–500	15.6	25.5	20.6	**< 0.001**
501–750	29.4	14.3	21.7	**< 0.001**
751–1500	32.6	4.2	18.1	**< 0.001**
Access to a car				
No	42.4	31.7	36.9	**< 0.001**
Yes	57.6	68.3	63.1	**< 0.001**
Smoking status				
Currently smoke	33.3	28.1	30.7	**0.02**
Smoked in the past	33.4	22.7	27.9	**< 0.001**
Never smoked	33.3	49.1	41.4	**< 0.001**
Disability				
No	84.0	87.1	85.6	0.07
Yes	16.0	12.9	14.4	0.07
Health limited				
Yes, limited a lot	13.1	13.8	13.5	0.68
Yes, limited a little	22.7	17.2	19.9	**0.005**
No, not limited at all	64.2	69.0	66.7	**0.04**
Dog ownership				
No	79.2	74.9	77.0	**0.04**
Yes	20.8	25.1	23.0	**0.04**
Children in household				
No	73.2	70.8	71.9	0.28
Yes	26.8	29.2	28.1	0.28
Site pair				
A	14.2	18.1	16.2	**0.03**
B	42.9	41.0	41.9	0.42
C	42.9	41.0	41.9	0.42

a *p*-values < 0.05 indicated in bold.
b Based on occupational categories, where I = highest grade occupations; V = state pensioners, unemployed or lowest grade occupations.
c Levels range from 1 (school leaver qualifications: O grade, standard grade or equivalent) to 4 (higher education qualifications: first degree or higher).

TABLE 39 Characteristics of participants at wave 2: panel B (cohort sample) (imputed data)

Variable	Site (%)		Total (%) ($N = 350$)	p-value for test of difference[a]
	Intervention ($n = 126$)	Control ($n = 224$)		
Age (years)				
16–24	4.5	1.3	2.6	0.10
25–34	11.9	13.8	13.1	0.60
35–44	13.5	11.2	12.0	0.53
45–54	20.6	15.6	17.4	0.25
55–64	10.3	20.5	16.9	**0.008**
65–74	16.6	19.6	18.6	0.49
≥ 75	22.2	17.9	19.4	0.33
Gender				
Female	67.5	67.9	67.7	0.94
Male	32.5	32.1	32.3	0.94
Life events				
Better than normal	3.2	10.3	7.7	**0.006**
Much worse than normal	14.3	14.7	14.6	0.90
No different than normal	37.3	26.3	30.3	**0.04**
Nothing has happened in last 12 months	45.2	48.7	47.4	0.54
Social class[b]				
I	1.6	5.0	3.8	0.07
II	12.9	19.9	17.4	0.09
III	14.0	11.5	12.4	0.54
IV	22.0	20.2	20.9	0.70
V	49.5	43.3	45.6	0.27
Highest level of qualification[c]				
No qualification	47.6	36.6	40.6	0.05
1	27.0	38.8	34.6	**0.02**
2	12.7	8.2	10.3	0.29
3	7.9	4.9	6.0	0.28
4	4.8	10.7	8.6	**0.04**
Working status				
No	69.8	69.4	69.5	0.91
Yes	30.1	30.8	30.5	0.91
Income coping				
Finding it difficult on present income	23.2	11.6	15.8	**0.01**
Coping on present income	53.6	59.0	57.0	0.34
Living comfortably on present income	23.2	29.4	27.1	0.21

continued

TABLE 39 Characteristics of participants at wave 2: panel B (cohort sample) (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 350$)	*p*-value for test of difference[a]
	Intervention ($n = 126$)	Control ($n = 224$)		
Distance to woods (m)				
≤ 150	7.9	27.2	20.3	**< 0.001**
151–300	15.9	21.4	19.4	0.19
301–500	19.0	21.4	20.6	0.59
501–750	34.9	17.8	24.0	**< 0.001**
751–1500	22.2	12.1	15.7	**0.02**
Access to a car				
No	50.8	33.5	39.7	**0.002**
Yes	49.2	66.5	60.3	**0.002**
Smoking status				
Currently smoke	35.9	26.1	29.7	0.06
Smoked in the past	27.3	27.4	27.4	0.98
Never smoked	36.7	46.4	42.9	0.08
Disability				
No	82.5	84.0	83.5	0.73
Yes	17.4	16.0	16.5	0.73
Health limited				
Yes, limited a lot	18.3	17.9	18.0	0.93
Yes, limited a little	23.0	23.7	23.4	0.89
No, not limited at all	58.7	58.5	58.6	0.96
Dog ownership				
No	80.9	72.3	75.4	0.06
Yes	19.0	27.7	24.6	0.06
Children in household				
No	78.6	76.3	77.1	0.63
Yes	21.4	23.7	22.9	0.63
Site pair				
A	25.4	15.2	18.9	**0.03**
B	61.9	33.5	43.7	**< 0.001**
C	12.7	51.3	37.4	**< 0.001**

a *p*-values < 0.05 indicated in bold.
b Based on occupational categories, where I = highest grade occupations; V = state pensioners, unemployed or lowest grade occupations.
c Levels range from 1 (school leaver qualifications: O grade, standard grade or equivalent) to 4 (higher education qualifications: first degree or higher).

TABLE 40 Characteristics of participants at wave 3: panel B (cohort sample) (imputed data)

Variable	Site (%)		Total (%) ($N = 402$)	p-value for test of difference[a]
	Intervention ($n = 168$)	Control ($n = 234$)		
Age (years)				
16–24	4.8	3.0	3.7	0.37
25–34	8.9	7.3	7.9	0.55
35–44	8.3	12.8	11.0	0.14
45–54	14.8	15.4	15.2	0.89
55–64	19.0	21.0	20.1	0.64
65–74	23.2	21.8	22.4	0.74
≥ 75	20.8	18.8	19.7	0.62
Gender				
Female	60.7	62.4	61.7	0.73
Male	39.3	37.6	38.7	0.73
Life events				
Better than normal	3.6	4.3	3.9	0.72
Much worse than normal	23.2	18.8	20.6	0.29
No different than normal	32.1	27.7	29.6	0.35
Nothing has happened in last 12 months	41.0	49.1	45.8	0.11
Social class[b]				
I	2.5	4.7	3.8	0.24
II	14.3	15.9	15.2	0.67
III	12.3	15.1	13.9	0.42
IV	23.2	23.8	23.5	0.90
V	47.7	40.6	43.6	**< 0.001**
Highest level of qualification[c]				
No qualification	57.1	37.4	45.7	**< 0.001**
1	23.2	31.2	27.9	0.07
2	13.1	12.0	12.5	0.75
3	3.6	11.2	7.9	**0.003**
4	3.0	8.1	5.9	**0.02**
Working status				
No	72.6	68.4	70.1	0.35
Yes	27.4	31.6	29.9	0.35
Income coping				
Finding it difficult on present income	24.6	9.0	15.5	**< 0.001**
Coping on present income	58.6	58.5	58.6	0.99
Living comfortably on present income	16.8	32.4	25.9	**< 0.001**

continued

TABLE 40 Characteristics of participants at wave 3: panel B (cohort sample) (imputed data) (*continued*)

Variable	Site (%)		Total (%) ($N = 402$)	p-value for test of difference[a]
	Intervention ($n = 168$)	Control ($n = 234$)		
Distance to woods (m)				
≤ 150	5.3	25.2	16.9	**< 0.001**
151–300	16.1	24.0	20.6	0.05
301–500	7.1	26.5	18.4	**< 0.001**
501–750	47.0	17.5	29.9	**< 0.001**
751–1500	24.4	6.8	14.2	**< 0.001**
Access to a car				
No	45.8	29.1	36.1	**< 0.001**
Yes	54.2	71.0	63.9	**< 0.001**
Smoking status				
Currently smoke	31.1	24.8	27.4	0.17
Smoked in the past	43.6	26.5	33.6	**< 0.001**
Never smoked	25.3	48.7	39.0	**< 0.001**
Disability				
No	78.6	81.0	80.0	0.55
Yes	21.4	19.0	20.0	0.55
Health limited				
Yes, limited a lot	20.8	18.0	19.2	0.47
Yes, limited a little	29.8	26.5	27.9	0.48
No, not limited at all	49.4	55.0	53.0	0.22
Dog ownership				
No	81.5	76.5	78.6	0.22
Yes	18.5	23.5	21.4	0.22
Children in household				
No	83.5	81.2	82.2	0.55
Yes	16.5	18.8	17.8	0.55
Site pair				
A	11.9	10.7	11.2	0.70
B	68.4	35.5	49.3	**< 0.001**
C	19.4	53.4	39.6	**< 0.001**

a p-values < 0.05 indicated in bold.
b Based on occupational categories, where I = highest grade occupations; V = state pensioners, unemployed or lowest grade occupations.
c Levels range from 1 (school leaver qualifications: O grade, standard grade or equivalent) to 4 (higher education qualifications: first degree or higher).

Appendix 5 Core survey data for key outcome variables

Descriptive statistics on secondary outcomes (waves 1, 2 and 3)

TABLE 41 Secondary outcomes at wave 1: panel A (cross-sectional sample) (imputed data)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Health-related outcomes					
Vigorous activity	589.44 (1827.30)	796.50 (2208.78)	692.72 (2028.77)	0.021	207.05 (89.58)
Moderate activity	761.13 (1583.18)	787.20 (1447.21)	774.16 (1516.58)	0.69	26.12 (66.37)
Walking activity	893.56 (1119.31)	1111.90 (1288.39)	1002.47 (1211.27)	< 0.001	218.34 (53.35)
Overall PA	2245.06 (3447.50)	2512.06 (3346.46)	2378.24 (3399.33)	0.08	267 (152.10)
Connectedness to nature	2.67 (1.62)	3.35 (1.48)	3.00 (1.59)	< 0.001	0.68 (0.07)
Social cohesion	8.54 (2.01)	9.15 (1.47)	8.84 (1.79)	< 0.001	0.60 (0.08)
Variable	Site (%)		Total (%)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Behaviour outcomes					
Nature visits					
No	51.6	44.6	48.1	0.001	n/a
Yes	48.4	55.4	51.9	0.001	n/a
Length of woodland visits					
No	27.3	40.0	34.8	0.001	n/a
Yes	72.7	60.0	65.2	0.001	n/a
Frequency of woodland visits/summer					
No	37.7	46.6	42.9	0.03	n/a
Yes	62.3	53.4	57.1	0.03	n/a
Frequency of woodland visits/winter					
No	62.8	61.8	62.2	0.81	n/a
Yes	37.2	38.2	37.8	0.81	n/a
Visual contact with nature					
No	48.3	34.9	41.6	< 0.001	n/a
Yes	51.7	65.1	58.4	< 0.001	n/a

continued

TABLE 41 Secondary outcomes at wave 1: panel A (cross-sectional sample) (imputed data) (*continued*)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Health-related outcomes					
Social support for environment use					
Awareness of the woods					
No	44.9	16.2	30.6	< 0.001	n/a
Yes	55.1	83.8	69.4	< 0.001	n/a
Go for a walk					
No	60.6	33.1	44.3	< 0.001	n/a
Yes	39.4	66.9	55.7	< 0.001	n/a
Walk a dog					
No	46.3	53.7	50.7	0.08	n/a
Yes	53.7	46.3	49.3	0.08	n/a
Go out with family					
No	75.8	65.4	69.6	0.007	n/a
Yes	24.2	34.6	30.4	0.007	n/a
Relax					
No	97.8	98.2	98.1	0.76	n/a
Yes	2.2	1.8	1.94	0.76	n/a
Enhanced environment					
Being away	3.07 (3.50)	4.44 (3.39)	3.75 (3.51)	< 0.001	1.37 (0.15)
Fascination	2.79 (3.18)	4.15 (3.23)	3.47 (3.27)	< 0.001	1.36 (0.14)
HRQoL					
EQ-5D	0.86 (0.25)	0.86 (0.24)	0.86 (0.25)	0.67	0.00 (0.01)

n/a, not applicable.

TABLE 42 Secondary outcomes at wave 1: panel B (cohort sample) (imputed data)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Health-related outcomes					
Vigorous activity	455.14 (1749.09)	836.91 (2467.35)	661.39 (2173.59)	0.03	381.77 (178.65)
Moderate activity	543.91 (1245.23)	777.01 (1438.73)	669.84 (1357.12)	0.04	233.10 (110.79)
Walking activity	842.90 (1081.05)	1082.75 (1364.06)	972.47 (1246.77)	0.02	239.85 (102.73)
Overall PA	1841.21 (3084.32)	2444.39 (3459.84)	2167.06 (3303.62)	0.03	603.18 (270.24)
Connectedness to nature	3.02 (1.63)	3.49 (1.43)	3.28 (1.54)	< 0.001	0.47 (0.12)
Social cohesion	8.73 (1.83)	9.13 (1.49)	8.94 (1.67)	0.004	0.4 (0.14)
Behaviour outcomes					
Nature visits					
No	47.5	49.2	0.48	0.67	n/a
Yes	52.5	50.8	0.52	0.67	n/a
Visual contact with nature					
No	47.1	36.2	0.41	0.01	n/a
Yes	52.9	63.8	0.59	0.01	n/a
Social support for environment use					
Awareness of the woods					
No	47.5	14.0	29.4	< 0.001	n/a
Yes	52.5	86.0	70.6	< 0.001	n/a
Enhanced environment					
Being away	3.41 (3.38)	4.22 (3.22)	3.85 (3.32)	0.003	0.808 (0.268)
Fascination	3.41 (3.28)	3.82 (2.99)	3.63 (3.13)	0.11	0.411 (0.254)
HRQoL					
EQ-5D	0.78 (0.29)	0.84 (0.25)	0.81 (0.27)	0.02	0.05 (0.020)

n/a, not applicable.

TABLE 43 Secondary outcomes at wave 2: panel A (cross-sectional sample) (imputed data)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Health-related outcomes					
Vigorous activity	500.27 (1599.63)	974.54 (2623.73)	764.64 (2241.11)	< 0.001	474.27 (110.11)
Moderate activity	705.72 (1455.27)	960.41 (1774.35)	847.70 (1645.21)	0.002	254.68 (81.13)
Walking activity	1247.43 (1537.55)	1290.39 (1542.16)	1271.37 (1539.81)	0.57	42.95 (76.07)
Overall PA	2450.12 (3338.69)	3173.16 (4502.96)	2853.15 (4044.25)	< 0.001	723.04 (199.62)
Connectedness to nature	2.84 (1.51)	3.68 (1.58)	3.31 (1.60)	< 0.001	0.84 (0.08)
Social cohesion	9.14 (1.86)	9.33 (1.64)	9.25 (1.75)	0.03	0.20 (0.09)

continued

TABLE 43 Secondary outcomes at wave 2: panel A (cross-sectional sample) (imputed data) (*continued*)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Behaviour outcomes					
Nature visits					
No	57.0	49.9	53.1	0.004	n/a
Yes	43.0	50.1	46.9	0.004	n/a
Length of woodland visits					
No	33.1	31.7	32.3	0.79	n/a
Yes	66.9	68.1	67.7	0.79	n/a
Frequency of woodland visits/summer					
No	48.0	47.6	47.7	0.94	n/a
Yes	52.0	52.4	52.3	0.94	n/a
Frequency of woodland visits/winter					
No	64.9	63.7	64.1	0.81	n/a
Yes	35.1	36.3	35.9	0.81	n/a
Visual contact with nature					
No	57.0	37.1	45.9	< 0.001	n/a
Yes	43.0	62.9	54.1	< 0.001	n/a
Social support for environment use					
Awareness of the woods					
No	45.8	25.1	34.3	< 0.001	n/a
Yes	54.2	74.9	65.7	< 0.001	n/a
Go for a walk					
No	60.1	56.8	58.0	0.5	n/a
Yes	39.9	43.2	42.0	0.5	n/a
Walk a dog					
No	64.2	53.5	57.2	0.03	n/a
Yes	35.8	46.5	42.8	0.03	n/a
Go out with family					
No	69.6	72.5	71.5	0.53	n/a
Yes	30.4	27.5	28.5	0.53	n/a
Relax					
No	94.6	97.8	96.7	0.12	n/a
Yes	5.4	2.2	3.33	0.12	n/a
Enhanced environment					
Being away	3.38 (3.56)	4.74 (3.19)	4.14 (3.43)	< 0.001	1.36 (0.17)
Fascination	3.41 (3.46)	4.57 (3.10)	4.06 (3.32)	< 0.001	1.16 (0.16)
HRQoL					
EQ-5D	0.87 (0.22)	0.87 (0.24)	0.86 (0.23)	0.9	–0.00 (0.01)

n/a, not applicable.

TABLE 44 Secondary outcomes at wave 2: panel B (cohort sample) (imputed data)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Health-related outcomes					
Vigorous activity	466.35 (1584.75)	760.32 (2257.82)	654.49 (2043.72)	0.20	293.97 (227.40)
Moderate activity	607.30 (1317.43)	891.49 (1774.17)	789.18 (1628.37)	0.12	284.19 (181.30)
Walking activity	999.09 (1193.11)	1162.79 (1600.11)	1103.86 (1466.99)	0.32	163.71 (163.58)
Overall PA	2071.79 (2822.57)	2836.85 (4438.18)	2561.43 (3946.52)	0.08	765.07 (439.82)
Connectedness to nature	3.24 (1.42)	4.00 (1.63)	3.73 (1.60)	< 0.001	0.76 (0.17)
Social cohesion	9.03 (2.25)	9.40 (1.53)	9.26 (1.82)	0.07	0.37 (0.21)
Behaviour outcomes					
Nature visits					
No	46.0	52.7	50.3	0.23	n/a
Yes	54.0	47.3	49.7	0.23	n/a
Visual contact with nature					
No	45.2	39.3	41.4	0.28	n/a
Yes	54.8	60.7	58.6	0.28	n/a
Social support for environment use					
Awareness of the woods					
No	38.9	26.3	30.9	0.02	n/a
Yes	61.1	73.7	69.1	0.02	n/a
Enhanced environment					
Being away	4.67 (3.53)	5.01 (3.3)	4.89 (3.38)	0.37	0.34 (0.38)
Fascination	4.71 (3.35)	4.7 (3.17)	4.7 (3.23)	0.98	0.01 (0.36)
HRQoL					
EQ-5D	0.81 (0.27)	0.79 (0.26)	0.80 (0.27)	0.67	0.01 (0.03)

n/a, not applicable.

TABLE 45 Secondary outcomes at wave 3: panel A (cross-sectional sample) (imputed data)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Health-related outcomes					
Vigorous activity	681.26 (2071.96)	788.01 (2303.55)	735.88 (2193.51)	0.32	106.75 (107.75)
Moderate activity	835.35 (1611.86)	697.01 (1464.88)	764.57 (1539.51)	0.07	138.34 (75.85)
Walking activity	1003.57 (1264.95)	1355.55 (1577.34)	1183.67 (1443.66)	< 0.001	351.98 (70.62)
Overall PA	2514.75 (3653.19)	2835.91 (4011.44)	2679.08 (3842.90)	0.09	321.16 (188.73)
Connectedness to nature	3.13 (1.27)	3.38 (1.69)	3.26 (1.50)	0.001	0.25 (0.07)
Social cohesion	8.88 (1.70)	8.94 (1.64)	8.91 (1.67)	0.49	0.05 (0.08)
Behaviour outcomes					
Nature visits					
No	50.9	59.3	55.2	0.001	n/a
Yes	49.1	40.7	44.8	0.001	n/a
Length of woodland visits					
No	18.8	26.5	22.7	0.07	n/a
Yes	81.2	73.5	77.3	0.07	n/a
Frequency of woodland visits/summer					
No	30.7	34.8	32.8	0.38	n/a
Yes	69.3	65.2	67.2	0.38	n/a
Frequency of woodland visits/winter					
No	65.8	55.9	60.8	0.04	n/a
Yes	34.1	44.1	39.2	0.04	n/a
Visual contact with nature					
No	53.4	23.3	38	< 0.001	n/a
Yes	46.6	76.7	62	< 0.001	n/a
Social support for environment use					
Awareness of the woods					
No	31.5	21.5	26.4	< 0.001	n/a
Yes	68.5	78.5	73.6	< 0.001	n/a
Go for a walk					
No	43.6	42.6	43.1	0.85	n/a
Yes	56.4	57.3	56.9	0.85	n/a
Walk a dog					
No	58.4	51.5	54.9	0.16	n/a
Yes	41.6	48.5	45.1	0.16	n/a
Go out with family					
No	67.3	55.4	61.3	0.01	n/a
Yes	32.7	44.6	38.7	0.01	n/a
Relax					
No	95.5	96.1	95.8	0.79	n/a
Yes	4.5	3.9	4.19	0.79	n/a

TABLE 45 Secondary outcomes at wave 3: panel A (cross-sectional sample) (imputed data) (*continued*)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Enhanced environment					
Being away	3.62 (3.30)	2.98 (3.75)	3.29 (3.55)	< 0.001	–0.63 (0.17)
Fascination	3.84 (3.23)	2.87 (3.63)	3.34 (3.47)	< 0.001	–0.97 (0.17)
HRQoL					
EQ-5D	0.81 (0.26)	0.85 (0.25)	0.83 (0.26)	< 0.001	0.04 (0.01)

n/a, not applicable.

TABLE 46 Secondary outcomes at wave 3: panel B (cohort sample) (imputed data)

Variable	Site, mean (SD)		Total, mean (SD)	*p*-value for test of difference	Difference (SE)
	Intervention	Control			
Health-related outcomes					
Vigorous activity	393.67 (1378.57)	365.64 (1480.56)	377.35 (1437.15)	0.85	–28.03 (146.39)
Moderate activity	833.57 (1645.49)	501.54 (1252.87)	640.3 (1437.58)	0.02	–332.03 (145.42)
Walking activity	1081.54 (1426.08)	1176.86 (1542.04)	1137.02 (1493.6)	0.53	95.32 (151.15)
Overall PA	2309.63 (3308.09)	2044.04 (3148.15)	2155.03 (3214.59)	0.42	–265.59 (326.77)
Connectedness to nature	3.21 (1.37)	3.54 (1.7)	3.40 (1.58)	0.04	0.33 (0.15)
Social cohesion	8.87 (1.92)	9.3 (1.58)	9.12 (1.74)	0.02	0.43 (0.18)
Behaviour outcomes					
Nature visits					
No	51.8	66.7	60.4	0.003	n/a
Yes	48.2	33.3	39.6	0.003	n/a
Visual contact with nature					
No	42.9	23.1	31.3	< 0.001	n/a
Yes	57.1	76.9	68.7	< 0.001	n/a
Social support for environment use					
Awareness of the woods					
No	35.7	19.2	26.1	< 0.001	n/a
Yes	64.3	80.8	73.9	< 0.001	n/a
Enhanced environment					
Being away	3.82 (3.37)	2.45 (3.64)	3.02 (3.59)	< 0.001	–1.37 (0.36)
Fascination	4.15 (3.25)	2.31 (3.45)	3.08 (3.48)	< 0.001	–1.83 (0.34)
HRQoL					
EQ-5D	0.75 (0.28)	0.80 (0.27)	0.78 (0.28)	0.05	0.06 (0.03)

n/a, not applicable.

Appendix 6 Data for intervention outcome in relation to perceived stress based on woodland distance bands and nature visits or views

TABLE 47 Intervention outcome for perceived stress by varying distance bands to local woods: panel A (cross-sectional sample)

	Wave					
	2			3		
Distance bands to local woods	Main effect	*p*-value	95% CI	Main effect	*p*-value	95% CI
Merging ≤ 150-m and 151–300-m groups						
0–300 m	1.33	0.07	–0.11 to 2.76	3.96	< 0.001	2.64 to 5.28
301–500 m	2.03	0.02	0.40 to 3.66	1.07	0.20	–0.58 to 2.72
501–750 m	3.27	< 0.001	1.68 to 4.87	4.29	< 0.001	2.67 to 5.91
751–1500 m	6.36	< 0.001	4.37 to 8.36	9.43	< 0.001	7.04 to 11.82
Merging 151–300-m and 301–500-m groups						
≤ 150 m	3.01	0.01	0.70 to 5.33	2.96	0.01	0.89 to 5.02
151–500 m	0.96	0.12	–0.24 to 2.16	2.67	< 0.001	1.47 to 3.87
501–750 m	3.44	< 0.001	1.84 to 5.04	4.38	< 0.001	2.75 to 6.01
751–1500 m	6.37	< 0.001	4.38 to 8.37	9.47	< 0.001	7.07 to 11.86

Note
Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, site pair, type of site (intervention or control), wave of survey and categorical variable on distance bands to local woods.

TABLE 48 Unadjusted patterns of perceived stress based on nature visits for panel A (cross-sectional sample) and panel B (cohort sample)

	Group					
	Nature visits			Non-nature visits		
Wave	Intervention (SD)	Control (SD)	Difference (SE)	Intervention (SD)	Control (SD)	Difference (SE)
Panel A: cross-sectional sample						
1	12.3 (6.6)	13.6 (5.6)	1.3*** (0.37)	12.1 (6.2)	15.2 (6.0)	3.1*** (0.39)
2	13.0 (6.9)	14.2 (6.1)	1.2*** (0.47)	13.9 (6.4)	13.6 (6.9)	–0.36 (0.45)
3	14.7 (6.2)	14.0 (6.7)	–0.69 (0.47)	15.2 (7.3)	12.6 (7.7)	–2.5*** (0.5)
Panel B: cohort sample						
1	13.7 (7)	14.3 (5.4)	0.62 (0.7)	13.9 (6.4)	15.8 (5.8)	1.9** (0.71)
2	13.4 (7.3)	14.8 (6.4)	1.4 (1.1)	15 (6.8)	13.8 (6.6)	–1.2 (1.1)
3	14.4 (6.9)	14.1 (6.8)	–0.29 (1.1)	16.6 (8.0)	12.9 (7.5)	–3.8*** (1)

*$p < 0.5$, **$p < 0.01$, **$p < 0.0010$.

TABLE 49 Unadjusted patterns of perceived stress based on nature views for panel A (cross-sectional sample) and panel B (cohort sample)

	Group					
	Nature visits			Non-nature visits		
Wave	Intervention (SD)	Control (SD)	Difference (SE)	Intervention (SD)	Control (SD)	Difference (SE)
Panel A: cross-sectional data set						
1	11.4 (6.8)	14.1 (5.8)	2.7*** (0.36)	13.0 (5.9)	14.8 (5.9)	1.8*** (0.4)
2	13.9 (7.2)	14.4 (6.1)	0.5 (0.45)	13.2 (0.3)	13.0 (7.2)	–0.23 (0.48)
3	13.7 (6.9)	12.9 (7.4)	–0.75 (0.46)	16.0 (6.5)	13.9 (6.9)	–2.1*** (0.56)
Panel B: cohort sample						
1	13.1 (6.9)	14.6 (5.6)	1.5* (0.7)	14.6 (6.3)	15.8 (5.6)	1.2 (0.76)
2	15.3 (8.1)	14.5 (6.4)	–0.74 (1.0)	12.8 (5.4)	13.9 (6.8)	1.1 (1.1)
3	14.9 (7.6)	13.0 (7.6)	–1.8 (0.9)	16.5 (7.5)	14.1 (6.1)	–2.4 (1.2)

*$p < 0.5$, **$p < 0.01$, **$p < 0.0010$.

Appendix 7 Results for intervention outcome in relation to mental well-being

TABLE 50 The WIAT intervention effect on mental well-being (SWEMWBS) by nature visits (augmented approach)

	Wave					
	2			3		
Group	Main effect	*p*-value	95% CI	Main effect	*p*-value	95% CI
Panel A: cross-sectional sample						
Nature visits group	–1.65	< 0.001	–2.42 to –0.87	0.91	0.02	0.13 to 1.68
Non-nature visits group	–2.83	< 0.001	–3.59 to –2.07	–1.81	< 0.001	–2.55 to –1.06
Panel B: cohort sample						
Nature visits group	–2.56	0.002	–4.15 to –0.98	0.32	0.70	–1.30 to 1.94
Non-nature visits group	–1.23	0.14	–2.88 to 0.41	–2.81	< 0.001	–4.28 to –1.35

Note
Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

TABLE 51 The WIAT intervention effect on mental well-being (SWEMWBS) by nature views (augmented approach)

	Wave					
	2			3		
Group	Main effect	*p*-value	95% CI	Main effect	*p*-value	95% CI
Panel A: cross-sectional sample						
Nature visits group	–1.63	< 0.001	–2.37 to –0.89	–0.38	0.29	–1.08 to 0.33
Non-nature visits group	–2.95	< 0.001	–3.76 to –2.13	–1.12	0.02	–2.02 to –0.22
Panel B: cohort sample						
Nature visits group	–1.40	0.07	–2.92 to 0.11	–1.35	0.06	–2.72 to 0.03
Non-nature visits group	–2.94	< 0.001	–4.69 to –1.19	–2.24	0.02	–4.06 to –0.43

Note
Multilevel models adjusted for age, gender, life events, social class, education, working status, income coping, access to car, smoking status, disability, health status, dog ownership, children, distance bands (to local woods: ≤ 150, 151–300, 301–500, 501–750 and 751–1500 m; i.e. five distance bands), site pair, type of site (intervention or control) and wave of survey.

Appendix 8 Cost–consequences analysis of the Woods In and Around Towns interventions

TABLE 52 Costs of the WIAT interventions

Intervention	Incremental expected cost (£)	95% CI (£)
Physical	7.68	7.67 to 7.69
Physical and social	11.80	11.79 to 11.82

TABLE 53 Primary and secondary outcomes used in CCA

	Panel			
	A		B	
Variable	Coefficient	95% CI	Coefficient	95% CI
Primary outcome				
Wave 2				
Stress level	1.52	0.78 to 2.27	1.11	–0.46 to 2.68
Wave 3				
Stress level	3.58	2.85 to 4.31	3.03	1.54 to 4.52
Secondary outcomes				
Wave 2				
Vigorous activity	–152.90	–422.60 to 116.80	41.24	–457.40 to 539.90
Moderate activity	–215.40	–409.40 to 21.39	–103.40	–470.60 to 263.80
Walking activity	203.30	36.81 to 369.80	–11.57	–346.00 to 322.80
Overall PA	–282.40	–732.10 to 167.30	–379.80	–1186.00 to 426.30
Connectedness to nature	–0.193	–0.380 to –0.005	–0.29	–0.674 to 0.102
Social cohesion	0.437	0.22 to 0.65	0.01	–0.39 to 0.41
Wave 3				
Vigorous activity	221.20	–43.46 to 485.90	382.30	–87.75 to 852.40
Moderate activity	249.20	58.25 to 440.10	559.30	211.30 to 907.20
Walking activity	–40.87	–204.50 to 122.80	144.10	–170.80 to 459.00
Overall PA	275.20	–163.20 to 713.50	861.50	106.5 to 1616.4
Connectedness to nature	0.387	0.20 to 0.57	0.15	–0.22 to 0.51
Social cohesion	0.496	0.29 to 0.70	0.02	–0.36 to 0.39

TABLE 54 Behavioural outcomes used in CCA

	Panel			
	A		B	
Behavioural outcomes	OR	95% CI	OR	95% CI
Wave 2				
Nature visits	1.33	0.94 to 1.88	1.56	0.80 to 3.05
Length of visit	0.433	0.18 to 1.02	1.43	0.77 to 2.67
Frequency of visits: summer	0.79	0.43 to 1.45	n/a	n/a
Frequency of visits: winter	1.45	0.66 to 3.18	n/a	n/a
Nature views	0.88	0.65 to 1.20	n/a	n/a
Wave 3				
Nature visits	2.69	1.90 to 3.80	2.77	1.45 to 5.29
Length of visit	0.83	0.36 to 1.90	0.64	0.35 to 1.18
Frequency of visits: summer	1.07	0.57 to 1.99	n/a	n/a
Frequency of visits: winter	0.82	0.38 to 1.77	n/a	n/a
Nature views	0.428	0.31 to 0.59	n/a	n/a

n/a, not applicable.

TABLE 55 Social support outcomes used in CCA

	Panel			
	A		B	
Social support outcomes	OR	95% CI	OR	95% CI
Wave 2				
Awareness of the woods	2.26	1.58 to 3.22	3.85	1.92 to 7.72
Go for a walk	2.98	1.55 to 5.74	n/a	n/a
Walk a dog	0.53	0.22 to 1.28	n/a	n/a
Go out with family	3.42	1.37 to 8.56	n/a	n/a
Relax	3.35	0.61 to 18.28	n/a	n/a
Wave 3				
Awareness of the woods	3.10	2.15 to 4.46	3.39	1.72 to 6.67
Go for a walk	3.30	1.73 to 6.29	n/a	n/a
Walk a dog	0.72	0.30 to 1.70	n/a	n/a
Go out with family	2.14	0.91 to 5.03	n/a	n/a
Relax	1.21	0.23 to 6.40	n/a	n/a

n/a, not applicable.

TABLE 56 Enhanced environmental outcomes used in CCA

Enhanced environmental outcomes – experience within the woods	Panel A		Panel B	
	OR	95% CI	OR	95% CI
Wave 2				
Being away	0.45	0.044 to 0.870	0.67	–0.14 to 1.49
Fascination	0.63	0.24 to 1.03	0.62	–0.17 to 1.41
Wave 3				
Being away	1.99	1.59 to 2.39	2.72	1.95 to 3.49
Fascination	2.27	1.88 to 2.66	2.69	1.94 to 3.43

TABLE 57 The HRQoL outcomes used in CCA

	Panel A		Panel B	
Wave	Coefficient	95% CI	Coefficient	95% CI
2	0.017	–0.007 to 0.040	0.044	–0.010 to 0.098
3	–0.007	–0.030 to 0.016	0.009	–0.043 to 0.060

EME
HS&DR
HTA
PGfAR
PHR

Part of the NIHR Journals Library
www.journalslibrary.nihr.ac.uk

Published by the NIHR Journals Library